МЕТАЛЛУРГ

METALLURGIST

(METALLURG)

IN ENGLISH TRANSLATION

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SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosenergoizdat	State Power Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LEIIZhT	Leningrad Power Inst. of Railroad Engineering
LET	Leningrad Elec. Engr. School
LETI	Leningrad Electrotechnical Inst.
LETIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MEP	Ministry of Electrical Industry
MES	Ministry of Electrical Power Plants
MESEP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTI	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NII ZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOE	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIEL	Central Scientific Research Elec. Engr. Lab.
TsNIEL-MES	Central Scientific Research Elec. Engr. Lab.–Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIESKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZEI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us. – Publisher.

THE NEW WAGE STRUCTURE IN THE FERROUS METALS INDUSTRY

M. N. Timoshpolsky

The 20th Party Congress has assigned to all branches of the national economy the task of increasing by all means the productivity of labor, and of further increasing on this basis the material well-being and the level of cultural development of the Soviet people. A technically higher standard of production calls for the simultaneous introduction of order into the organization, rate fixing, and wages.

During recent years a discrepancy has appeared in the enterprises of many branches of the industry between the achieved wage level and the wage rates. The existing wage structure became an obstacle to the scientific fixing of rates and has an adverse effect upon further increase in the productivity of labor.

More than 70 various wage scales are now in use in the enterprises of the ferrous metals industry. Some enterprises use up to 26 different wage scales. The pay on the wage-rate basis represents on the average 62.8% of the earnings of workers in the ferrous metals industry, or 57.9% if long service pay is taken into account. This prevents the extensive use of scientifically fixed rates of output, and often causes the introduction of unnecessary premium schemes. In some plants of the metals industry the output rates are sometimes fulfilled to 130-140%, the average being 115-125%. The difference between the planned output and the output fixed in rate fixing reaches 20% and more. In the auxiliary sections of main plants the output rates are being overfulfilled on the average to 130-140% and in the auxiliary plants the average percentage is 150. The award of collective premiums has now lost its incentive value as the collective premium for the 100% fulfilment of the plan amounts now to 15% of piecework earnings, and not to 40% which was fixed in 1939.

The existing wage system is difficult to understand by the worker and is very complicated for the calculation of wages.

In view of the fact that the progressive bonus and the collective premium constitute a substantial proportion of workers' earnings in the leading trades of metal-producing shops, insignificant variations in the rate of fulfilment of the plan effect sharp changes in earnings. If, for example the plan is 100% fulfilled and the fixed output rate is 115% a class 12 steel-furnace operator earns on the average 1,623 rubles, but if the plan is 95% fulfilled and the fixed output rate is 109%, his earnings are 1,225 rubles.

Because of the low wage rates of the time-rate workers they are paid a bonus of up to 56% of the wage rate if the production plan of the department is fulfilled or exceeded; if the plan is not fulfilled, the premium is not paid and the earnings of time-rate workers fall sharply.

In 1957 it is intended to reduce the working day of miners and technicians on underground work to 6 hours, and of other workers and technicians on surface work in mines, in metal and coke by-product works, and in open-cast mining and enrichment of ores to 7 hours. At the same time it is intended to increase and to streamline the wages of workers and technicians in the mining, metals and coke by-product industries.

In order to rationalize rate fixing and the fixing of wages, it is necessary to introduce on a large scale scientifically fixed output rates, to increase the wage rates (salaries), to increase the proportion of basic wages in the total earnings of workers, and to eliminate the multiplicity of incentive payment systems.

The adoption of a shorter working day and the introduction of the new remuneration methods in underground work will take place in the third quarter of the year, while in the metal and coke by-product works, in surface work in mines, and in the enrichment of ores it is scheduled for the period from September to December 1957.

No unnecessary haste should be shown by the executives of enterprises in the transition to the shorter working day and to the new wage structure. With the widest participation of politically active workers and technicians in ore mining and metal production, thorough preparatory work must be carried out in connection with productivity of labor and production costs, in order to achieve the set targets despite the shortened working day.

The preparations for the introduction of a shorter working day must include the working out of work schedules for workers and salaried staff engaged in continuous production, and for those engaged in non-continuous work. A detailed study must be made regarding the number of various trades required for shift work in continuous production; and measures planned for combining trades and cutting the number of unskilled personnel; and for beginning the training of the necessary skilled personnel.

In the enterprises belonging to the first wage group the following daily wage rates have been approved for various wage classes (for a 7-hour day).

For productive workers in metal-producing and coke by-product departments:

Class	1	2	3	4	5	6	7	8	9	10
Wage rates (rub.-kop.)	20-00	22-60	25-60	29-00	32-90	37-40	42-60	48-60	55-60	64-00

For workers in auxiliary departments of metal-producing and coke by-product works, as well as for workers on hot, heavy work, and on work in unhealthy conditions:

Class	1	2	3	4	5	6	7	8
Wage rates (rub.-kop.)	17-60	20-20	23-20	26-70	31-10	36-30	42-20	49-30

For piece-rate workers on cold work and day-rate workers on hot, heavy work and on work in unhealthy conditions:

Class	1	2	3	4	5	6	7	8
Wage rates (rub.-kop.)	15-60	17-90	20-60	23-70	27-60	32-10	37-40	43-70

For day-rate workers on cold work:

Class	1	2	3	4	5	6	7	8
Wage rates (rub.-kop.)	13-70	15-70	18-10	20-80	24-20	28-20	32-90	38-40

On the average the wage rates will be increased by about 49%.

The existing piece-work and premium schemes will be replaced by bonuses paid to workers engaged in ore mining and beneficiation as well as in the productive work at production units (furnaces and machines) and in the adjoining sections of metal-producing and coke by-product departments; these bonuses amount to 10, 15, and 20% of the monthly piece-work earnings for the fulfilment of the plan, and to 1, 1.5 and 2% of these earnings for each per cent by which the plan has been exceeded. The maximum bonus rates are intended for workers of leading trades working at the main production unit.

The new wage structure is straightforward and easily understood; it renders the calculation of wages considerably simpler than before.

It is permissible to use a progressive piece-rate scheme involving the payment of one and a half or two times the monthly piece-work rates for exceeding the monthly output rates, to operators working at production units and in sections of main departments not having a fixed production plan. For example, the progressive piece-rate wage scheme can be applied to workers engaged in finishing, sorting and straightening metal in rolling and tube-rolling shops.

Straight piece-work rates depending on the operative results of the production plants being serviced, with an additional bonus of up to 15% of the wage rate for the quality of maintenance and the reduction of breakdowns, are fixed for the maintenance staff (fitter, electricians, etc.) of main production departments.

Piece-rate workers engaged in the repair of furnaces and other equipment will be awarded bonuses of up to 15% of wage rates for high-quality work performed according to, or ahead of, the schedule.

The bonuses for the piece-rate workers mentioned can be paid only when the scheduled monthly output targets are achieved.

If necessary, a system of progressively rising piece-work rates involving the payment of one and a half times the fixed rates can be used to pay piece-rate workers employed in auxiliary departments, and in sections for which the scientifically calculated output rates are in operation. This scheme can also be applied to turners and the operators of milling, planing, drilling and other machines.

The operatives working on the time-rate basis will receive a bonus of up to 20% of their wage rates for high-quality work, if the plant, section, or department in which they work, achieves the production target. A model bonus scheme will be approved to prevent contention in awarding bonuses to piece-rate and day workers; similar regulations clearly defining the size of bonuses and the terms under which they are awarded must be worked out for every section by the individual enterprises, and approved by their directors.

Organization and labor research laboratories at "Zaporozhstal", Petrovsk and Dzerzhinsk metal works and at the Lenin Tube-Rolling Works have worked out model rating charts for the production equipment of metal-and tube-rolling works, to assist in scientific rate fixing. At the "Azovstal" works photo time studies were used to determine the time allowances in the manufacture of steel structures, for maintenance-engineering work in the repair of equipment in main departments, and for welding work. Considerable work was also carried out at the Magnitogorsk Metal Combine to ascertain the rating of equipment and to determine the output rates.

However, Makeevka, Voroshilov and some other works are slow in carrying out this work which is indispensable for the adoption of the shorter working day, and for the introduction of the new wage structure.

New salaries for the executive and technical staff of metal and coke by-product works were approved at the same time as the new wage structure.

Members of the technical staff of production departments are eligible for a premium only when the plan is fulfilled to 100% or more, and not, as before, from 90% onward.

The implementation of measures aimed at the rationalization of wages and salaries and at the shortening of working hours is closely linked with the need to improve the utilization of production reserves, for a substantial improvement in the intensity of use of equipment, and for the elimination of breakdowns and unintended stoppages; this calls for persistent introduction of modern experience and techniques, as well as for an improved operational management. The industrial, party and trade union organizations must at all times insist that the continuous increase of output, the improvement of quality, the lowering of production costs and the rise in the productivity of labor are in the financial interest of workers and technical supervisory staff, and should be unfailingly observed as a principle.

OPERATION OF BLAST FURNACES AT HIGH TOP PRESSURE

I. A. Kuzmin

(Blast furnace superintendent at the Cherepovets plant)

In the blast furnace shops of the Cherepovets plant, there are two furnaces of 1007 and 1033 cu m effective volume designed for operating at a high top pressure of 1.5 atm gage. Since April, 1956, furnace No. 1 has been operating at a high top pressure of over 1 atm. The use of self-fluxing sinter with a basicity of 1.15, high top pressure, improved operational conditions in the furnace and the organization of labor, has enabled the blast furnace coefficient to be lowered to 0.73 (see graph).

On blast furnace No. 2, the blast furnace coefficient* was reduced from 0.84 in June, 1956 to 0.74 at the present time.

Coke consumption per ton of iron produced for steelmaking has been reduced from 750 to 690 kg while the reduction in coke consumption per ton of foundry iron was from 770 to 730 kg; consumption of metal additions was 67 kg per ton of foundry iron and 14 kg per ton of pig iron for steelmaking (February 1957). In individual months of 1956, coke consumption per ton of steelmaking pig iron was reduced to 670 kg and, for foundry iron, to 700 kg. Such a comparatively small difference in coke consumption is explained by the fact that, when smelting foundry iron, practically all the raw limestone is excluded from the burden and the consumption of low grade manganese ore containing more than 30% of silica is considerably reduced. In addition, when smelting foundry iron, slag basicity is somewhat lower than when producing pig iron for steelmaking.

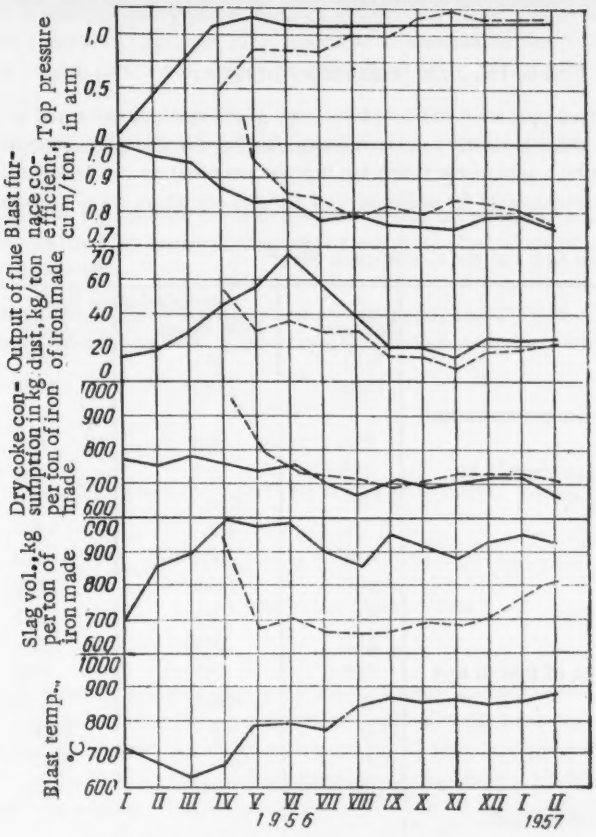
Slag output per ton of iron is very high. It varies from 850 to 980 kg per ton of steelmaking iron and from 700 to 800 kg per ton of foundry iron. This is due to the high silica content in the Olenegorsk (Deer Mountain) concentrates, the addition of up to 20% of pyrite cinders to the ore portion of the sinter burden and the greater consumption of low grade manganese ore since the plant has still not gone over to the smelting of low manganese steelmaking pig irons. The sulfur content of the iron is quite low: 0.019 to 0.035% in steelmaking iron and 0.018 to 0.022% in foundry iron.

The comparatively low coke consumption associated with high slag volume is mainly due to the use of self-fluxing sinter in the burden and to the uniform operation of the furnace.

High top pressure enabled the rate of smelting to be increased from 800 to 1000 kg of coke per cu m per 24 hours when producing pig iron for steelmaking. A 0.1 atm increase in top gas pressure in the range 0.7 to 1.2 atm enabled blast consumption to be raised by 50 cu m per minute while maintaining the former pressure drop of 0.9 to 1.1 atm.

With a brief drop in top gas pressure to normal, furnace productivity fell and coke consumption rose since blast volume and temperature were reduced. Thus, when top gas pressure was lowered from 1.1 to 0.15 atm,

* To assess the performance of blast furnaces, the Soviet authorities have adopted a standard of evaluation. This is called the "blast furnace coefficient" and is the working volume in cubic meters from the center line of the iron notch to the rim of the large bell in the lowered position, divided by the number of metric tons of iron produced per 24 hours, i. e., it is the working volume in cubic meters required to produce one ton of iron per 24 hours – Publisher's note.



Operational indices of blast furnace No. 1 in 1956 and 1957. The continuous curve refers to the smelting of iron for steel-making and the dashed line refers to foundry iron.

blast volume was reduced from 1950 to 1650 cu m per min at N. T. P. and blast temperature from 900 to 850°C; furnace productivity was cut by 17% while coke consumption rose by 4%. This occurred in spite of the fact that the pressure drop averaged 0.1 atm more than normal.

In this connection, serious efforts are being made at the plant to go over to continuous operation at high top pressure. Shift personnel keep a careful watch on the iron notch. Each month, the electric taphole guns undergo preventive maintenance. The pneumatic mechanical stoppers operate faultlessly.

In recent months, the blast furnaces have been operating on high top pressure for more than 99% of the total operating time. For 14 months in 1956-1957, stoppages of the blast furnace plant were 0.7% of the operating time, of which 0.2% was for reasons directly connected with high top pressure operation.

Increasing the top pressure from 0.2 to 1.1 atm made it possible to increase the productivity of furnace No. 1 for the period from January to April, 1956 from 1000 to 1230 tons per day because of the increased rate of smelting.

The volume of flue dust at 1.1 atm pressure did not usually exceed 20 to 25 kg per ton of iron.

Parallel to the increase in blast volume with top pressure of up to 1.1 atm, blast temperature was raised by an average of 100°C — from 650 to 750°C. A further increase in productivity at that gas pressure was obtained mainly by reducing coke consumption per ton of iron, a gradual increase in blast temperature from 750 to 880°C and a drop in blast humidity from 25 to 15 g/ cu m.

The comparatively low blast consumption is associated with optimum pressure drop and stable furnace operation.

Operational indices of blast furnace No. 1 are presented in the table.

Every check to uniform furnace operation indicated by drops of the stock detector rod or observed on the peripheral gas temperature chart is slowly eliminated by changing the charging sequence, by modifying the rotating distributor program or by a temporary reduction in blast temperature and volume. The only technologist on the furnace who is responsible for uniformity of furnace operation is the foreman.*

Operational Indices of Blast Furnace No. 1 at the Cherepovets Plant

Index	Periods during 1956			
	February	1-26 March	April	May
Top gas pressure in atm	0.13	0.34	0.9	1.0
Productivity in tons per 24 hours	1035	1055	1163	1227
Smelting rate expressed as kg of coke per cu m per 24 hours	770	800	880	900
Coke consumption per ton of iron produced, in kg	752	757	764	746
Equivalent iron content of sinter in %	57.8	57.4	56.7	57.4
Sinter basicity	1.23	1.3	1.3	1.16
Slag volume per ton of iron in kg	875	910	940	930
Blast volume in cu m per min	1506	1520	1722	1700
Blast temperature in °C	693	626	727	770
Throat temperature in °C	265	295	288	260
Equivalent coke consumption per ton of iron in kg*	752	750	749	732
Down time in hours and minutes	5-27	2-03	3-13	2-04
Blast humidification in g per cu m	18.9	19.9	20.6	24.8
CO_2 content of gas in %	12.0	10.8	10.9	11.9
Pressure drop in atm	1.06	1.14	1.15	1.11
Increase in rate of smelting for every 0.1 atm increase in pressure, expressed as tons of coke burnt per cu m per 24 hours	–	0.014	0.014	0.014

* Coke consumption is referred to the iron content of the sinter.

Because of uniform furnace operation and the very small volume of flue dust, charging gear life was improved. The charging gear on furnace No. 1 lasted for more than one and a half years with the furnace operating on high top pressure for over a year. There are, at present, some slight leakages in this charging gear which prevent pressure from being raised above 1.1 atm. When the top gear is changed, the built-up big bell hopper will be replaced by a one-piece hopper.

Cherepovets sinter is usually very fine. It contains, in all, 15% of +25 mm and 70% of 5 to 25 mm fraction.

Observations showed that the sinter strength index accepted at all plants — the trommel test — cannot serve as a criterion of quality of highly self-fluxing sinter. Under practical sintering conditions, it is essential to include granulometric requirements in addition to specifying chemical composition (even if the trommel test has to be excluded). The over fine grinding of self-fluxing sinter is caused by the method of cooling in hoppers and conveyers including abundant water spraying. The poor grinding of Pikalev limestone (up to 65% of 0 to 3 mm fraction) is associated with coarse lime impregnation of the sinter which reduces its strength during water spraying.

In order to prevent the sinter and coke from being reduced to too fine a size when fed by conveyer to the blast furnace, special types of chute are installed at the transfer points to soften the impact during transfer.

* The system of superintendents, managers, foremen and masters differs between U.S.S.R. and U.K. and U.S.A. so that this information is relatively meaningless — Translator's note.

Foundry iron is smelted solely on the basis of self-fluxing sinter almost without any addition of limestone to the blast furnace burden. As early as 1955, practical experience showed that the exclusion of 100 kg of raw limestone from the burden means a saving of 35 to 40 kg of coke. This is also confirmed by Professor A. N. Ramm's calculations.

After charging gears and electric taphole guns have been replaced by more powerful ones, top pressure will be raised to 1.5 atm.

Further increase in top pressure is limited by the poor heat-resisting properties of the blowpipes. When these blowpipes are replaced by heat-resisting steel blowpipes, blast temperature will be raised to over 950°C with medium humidification.

Plant operation can be markedly improved. To this end, exploitation of the Yen ore mines must be speeded up and the plant must go over to the production of low manganese iron for steelmaking.

USE OF HAMMER MILLS IN CRUSHING LIMESTONE

L. R. Migutsky and N. N. Grigoryev

Cherepovets Metal Works

The limestone crushing sections still remain a bottleneck in agglomeration plants producing fluxed agglomerate. Their output is unable to ensure the production of agglomerate with the required degree of basicity. The designs of the institute Mekhanobr provide 2.1 m x 3 m rod mills for the main crushing unit. The output of these mills is 10-15 ton/h, their installation requires a considerable capital outlay and their operation consumes much labor. The installation of rod mills for limestone crushing must be considered an error.

Such an error was made in designing the limestone crushing section of the agglomeration plant in the Cherepovets Metal Works, where two rod mills were installed. Before feeding into this mill, the limestone was crushed in a SM-19A hammer mill.

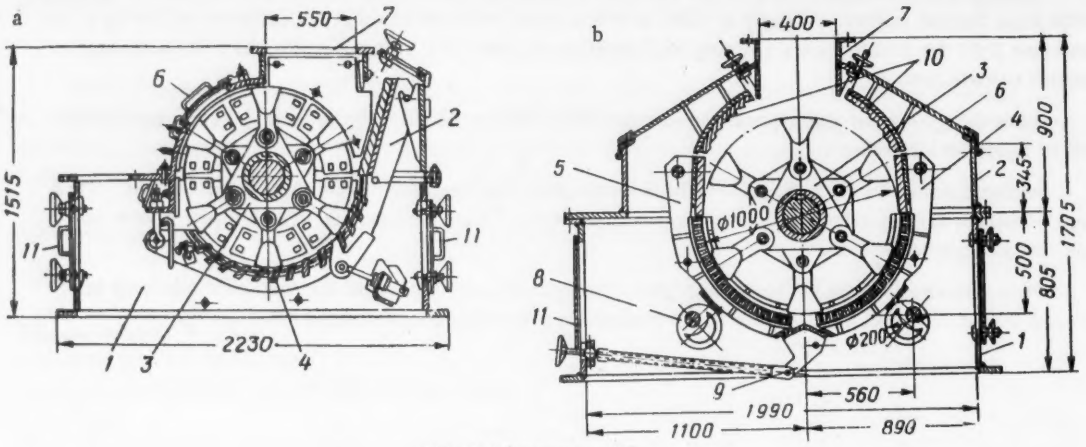
The low capacity of these mills and the unsatisfactory operation of the vertical conveyor which carried the limestone from the hammer mill to the rod mill necessitated an alteration in the limestone crushing process.

The authors suggested that the limestone should be crushed in hammer mills. For this purpose, in February 1956, the SM-19A hammer mill was altered as shown in the figure. In the course of reconstruction, the lower part of the machine body, welded from 16 mm plate, remained unchanged. The rotor of the machine was also left unaltered. The top part of the machine casing was, however, redesigned; the feed-hopper flange was moved into the center, and the spherical armor plates were fixed symmetrically on hinged lids. The left-hand and the right-hand gratings were made interchangeable, and their removal simplified. Each grating is made as a rigid welded structure consisting of two side plates and two cross plates. Flat bars of 40 Kh steel are placed with a clearance of 7 mm in the grooves of side plates. The bars are 10-12 mm thick and 60 mm wide. The gap between the bars is trapezoidal in section, and can therefore not be clogged with limestone.

The clearance between hammers and the grating can be regulated by means of a screw-operated cam device. A metal sheet is placed between the grates to collect the metal pieces which occasionally fall into the limestone. During the breaks in the operation of the mill, the sheet is lowered and metal pieces removed.

The windows in the casing faces have been retained for the inspection of grating and for repair purposes.

Table 1 shows that the rod mills represent the most expensive, and the SM-19A-R hammer mills the cheapest means of crushing limestone.



SM-19A hammer mill.

a) Before reconstruction; b) after reconstruction; 1) lower part of the machine body; 2) top part of the machine body; 3) rotor; 4 and 5) grating; 6) hinged lids; 7) hopper flange; 8) cam devices; 9) tray for collecting metal pieces; 10) armor plates; 11) inspection windows.

TABLE 1

Data Characterizing Crushing of Limestone in Different Mills of the Agglomerate Plant

Characteristics	SM-19A-R hammer mill	1450 x 1320 hammer mill	Rod mill
Output, ton/h	25	40	12
Power consumption in crushing limestone, kw-hr/ton	4.6	9.2	12.9
Metal consumption per 1 ton of crushed limestone, kg	0.02	0.03	0.05
Cost of the unit, thousand rub.	37.2	156.3	165.3
Weight of the unit, ton	6.5	15.5	55.0
Installation costs, rub.	1570	3800	7658
Motor horse-power, kw	115	370	155

TABLE 2

Sizes of Limestone after Crushing in Rod Mill and in Hammer Mill

Size, mm	Sizes of limestone, %		
	Before crushing	After crushing	
		In rod mill	In hammer mill
+ 150	9.74	–	–
150-50	55.19	–	–
50-25	28.81	–	–
25-5	4.27	–	–
5-3	0.23	6.43	4.48
-3	1.76	93.57	95.52

Table 2 shows that the output in sizes below 3 mm is higher in the case of the hammer mill than in the case of the rod mill. Considering the fact that the material leaving the hammer mill is not passed over a screen for checking purposes, the question arises whether the installation of screens behind the hammer mills is at all necessary.

The fight against dust in fine-grinding of limestone presents no special difficulties. If the water content of the limestone is above 2%, the dust produced by hammer mills is very small.

No heavy foundations are required for the installation of the SM-19A-R hammer mill. It can be mounted on floors other than the ground floor; this is very essential for agglomeration plants already in operation, since it is very difficult to carry out substantial construction work in limestone crushing sections when they are in operation.

The manufacture of SM-19A-R crushers for fine-crushing of limestone should be entrusted to an engineering works. If necessary, however, this mill can be built in machine shops of metal works.

SELECTION OF REFRACTORY CHEQUER BRICKWORK FOR HIGH- TEMPERATURE OPERATION OF HOT BLAST STOVES

N. D. Kirichenko

Gipromez

The use of hot blast of increased temperature in blast furnace operation results in an economy of coke and in a higher output of the furnace. During the past five years the hot blast temperature has been raised by about 250°C and in some furnaces now reaches temperatures of up to 900°C.

The operation of blast furnaces at even higher hot blast temperatures can be facilitated by the following measures: improved design of stove fittings, viz. hot blast valve, gas burner, tuyere device; improved quantity and higher calorific value of heating gas; use of a refractory with a higher heat resistance in the lining of the combustion chamber and dome and in the top stages of chequer brickwork.

Let us determine by means of comparative thermal calculations the most suitable design of the chequer brickwork for heating blast to 1,000°C in the stove of a standard 1,033 m^3 blast furnace. The characteristics of these stoves are as follows:

Inside dimensions of chequer channels, in mm	60 x 60
Height of chequer brickwork, in m	32.1
Height of stove, in m	40.2
Free cross-sectional area of chequer chamber, in m^2	10.04
Heating surface of chequer brickwork, in m^2	21,450
Weight of bricks, in tons	1,610
Diameter of stove, in m	8.5
Number of stoves	3
Cross-sectional area of the chequer brickwork chamber, in m^2	33.7
Free cross-sectional area of combustion chamber, in m^2	4.35
Quantity of air blast being heated, in nm^3/hr	143,000
Temperature of blast, in °C:	
cold	80
hot	844
Temperature of combustion products at the entry from the chequer brickwork, in °C	1,150
Temperature of combustion products at the exit from the chequer brickwork, in °C	147
Quantity of gas consumed in one stove, in nm^3/hr	25,100
Calorific value of gas, in cal/m^3	918
Duration of a gas cycle, in hrs.	1.9
Temperature drop of hot blast, in °C/hr	215

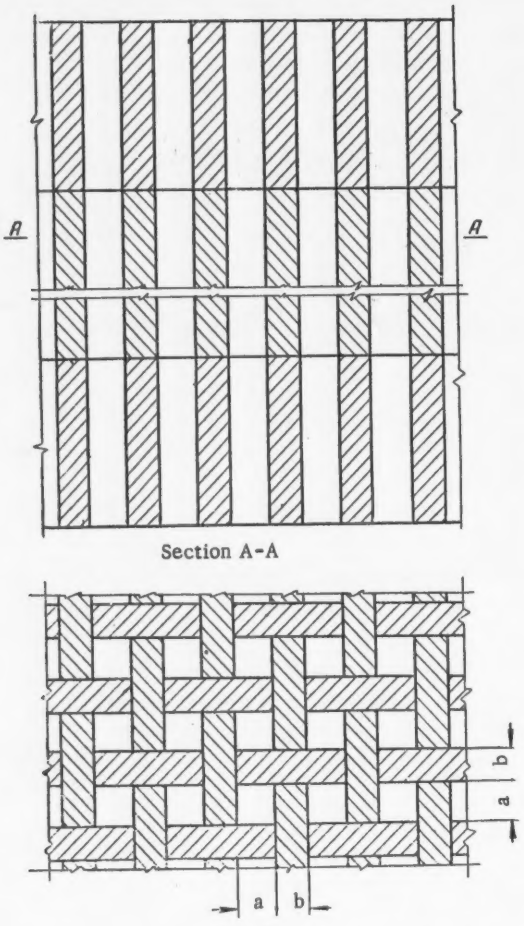


Fig. 1. Single-stage chequer brickwork with square channels:
1st variant: a) 60 mm; b) 50 mm; 2nd variant:
a) 45 mm; b) 40 mm.

The so-called single-stage chequer brickwork with through-channels used in the stoves of standard blast furnaces is laid of normal 170 x 150 x 50 mm bricks (GOST 1599-53), the section of channels is 60 x 60 mm and wall thickness 50 mm.

In our thermal calculations we shall consider three alternative types of chequer brickwork: 1st variant — plain single-stage brickwork with a channel section of 60 x 60 mm (Fig. 1); 2nd variant —same single-stage brickwork laid with 130 x 150 x 40 mm bricks and having channel sections reduced to 45 x 45 mm and a wall thickness of 40 mm (Fig. 1); 3rd variant — two-stage brickwork with a channel section of 110 x 110 mm and a wall thickness of 60 mm in the top (first) stage, made from 280 x 150 x 60 mm bricks; in the bottom (second) stage the size of channels is 130 x 45 mm, wall thickness 40 mm, and they are made of two 300 x 150 x 40 and 130 x 150 x 40 mm bricks (Fig. 2).

Thermal calculations are carried out for the same operational conditions for all three types of chequer, assuming that all three stoves have the same cross-sectional area.

The characteristic data of 1 m^3 of chequer brickwork are given in Table 1. They indicate that the heating surface of a unit volume of brickwork is, in the case of the single-stage brickwork of the second type, 25% larger than that of the first type; nevertheless the heat transfer per unit heating surface is in both cases about the same, since the difference in the free section of these two types of chequer is insignificant.

In the case of the two-stage brickwork (third variant) the heating surface of the second stage (130 x 45 mm chequers) is, in the same conditions, also increased by 22%, while the weight per unit brickwork volume is reduced by 18%, which renders the free section of the bottom stage of chequer brickwork too large.

Below are given the operational characteristics of a hot blast stove in the same working conditions.

Quantity of blast being heated, in nm^3/hr	163,800
Temperature, in °C:	
cold blast	150
hot blast	1,000
combustion products at the entry into the brickwork	1,250
combustion products at the exit from the brickwork	300
Quantity of gas burnt in one stove, in nm^3/hr	35,850
Calorific value of gas, in cal/m^3	950
Duration of the gas cycle, in hrs	1.9
Duration of the blast cycle, in hrs	1.0

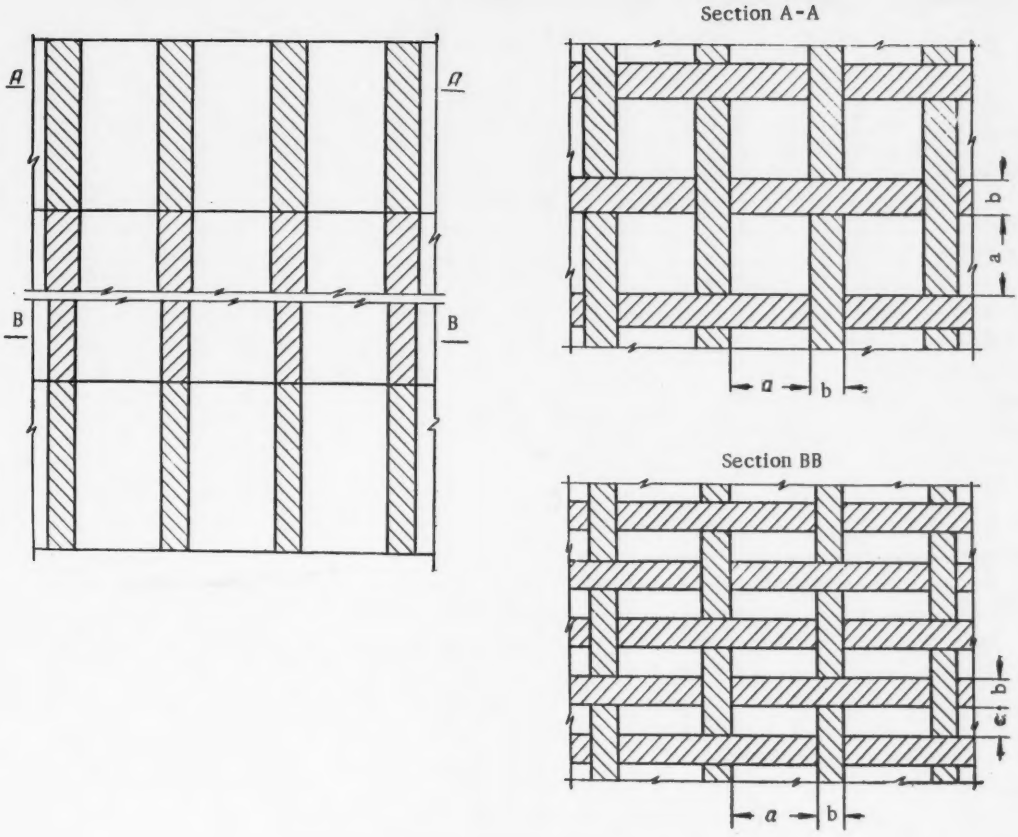


Fig. 2. Two-stage chequer brickwork: Square channels in the top stage: a) – 110 mm; b) – 40 mm; rectangular channels in the bottom stage: a) – 130 mm; b) – 40 mm; c) – 45 mm.

The results of thermal calculation of all three types of chequer brickwork are summarized in Table 2.

The figures in Table 2 indicate that in equal operational conditions the heating surface, weight and height of chequer brickwork is least in the stove of the second type.

The height and heating surface characteristics are the least satisfactory in the case of the third type, while the weight characteristic is worst in the single-stage brickwork of the first type.

Taking the figures of the first variant as 100%, the height of the chequer brickwork can be reduced by 25% if it is laid according to the second variant: the weight of fire-bricks is in this case reduced by 24%. The required heating surface can be reduced by 6%.

The height of chequer brickwork of the third type is about the same as that of the first type, but this chequer is 15% lighter and requires a 19% larger heating surface.

For the same temperature of hot blast (1,000°C) the drop of temperature during a cycle is greatest (254°C) in the stove with the chequer of the second type.

TABLE 1

Characteristic Data of 1 m^3 of Chequer Brickwork

Characteristics	Variant of chequer			
	first	second	third	
			first stage	second stage
Free cross-sectional area of channel, in mm	60 x 60	45 x 45	110 x 110	130 x 45
Wall thickness, in mm	50	40	60	40
Heating surface, in m^2/m^3	19.83	24.9	15.2	24.2
Weight, in kg/m^3	1475	1510	1220	1250
Free area, in %	29.8	28	41.8	40.5

TABLE 2

Design Data of Hot Blast Stoves

Characteristics	Variants of chequer				
	first	second	third		
			first stage	second stage	total
Free area of channel, in mm	60 x 60	45 x 45	110 x 110	130 x 45	—
Height of brickwork, in m	29	21.6	2.71	26.35	29.06
Height of stove, in m	37.1	29.7	—	—	37.16
Free area of brickwork chamber, in m^2	10.04	9.44	14.12	13.68	—
Heating surface of chequer brickwork of 1 stove, in m^2	19,300	18,100	1,400	21,500	22,900
Weight of bricks in 1 stove, in tons	1,442	1,092	111	1,110	1,221
Diameter of stove, in m	8.5	8.5	—	—	8.5
Number of stoves	3	3	—	—	3
Cross-sectional area of brickwork chamber, in m^2	33.7	33.7	—	—	33.7
Free cross-sectional area of brickwork chamber, in m^2	4.35	4.35	—	—	4.35

Taking the temperature drop in the brickwork of the first type during a cycle (212°C) as 100%, the drop in the brickwork of the second type is 20% higher, and in that of the third type 26% lower (156°C).

The calculation results of all three types of plain chequer brickwork show that, with regard to capital outlay, not every two-stage brickwork is better than a single-stage type. For instance, the height of hot blast stoves is greatest when the two-stage chequer brickwork of the third type is used. This can be explained by the unsatisfactory heat transfer in the smooth 130 x 45 mm channels in the bottom stage of the brickwork.

In order to improve the heat transfer in the two-stage brickwork, the bottom stage must have bricks reaching into the channel and active horizontal passages, creating an artificial turbulence in the flow of gas and air. This will not only improve the heat transfer but also reduce the weight and size of brickwork.

TABLE 3

Relative Characteristics of Three Types of Chequer Brickwork, Calculated for the Same Operational Conditions

Characteristics	Variants of brickwork			Chequer brickwork of stoves of the standard 1,033 m^3 blast furnace
	first	second	third	
Weight of bricks in 1 stove per 1 m^3/min of blast, in kg	545	412	460	670
Heating surface of 1 stove per 1 m^3/min of blast in m^2	7.3	6.8	8.6	8.9
Heating surface of 1 m^3 of brickwork, in m^2	19.83	24.9	15.2-24.2	19.83
Weight of 1 m^3 of brickwork	1,475	1,510	1220-1250	1,475
Weight of brickwork per 1 m^2 of heating surface, in kg	75	61	52-80	75

Table 3 shows that the single-stage brickwork of the second type has the best operational characteristics.

Thermal calculations also indicate that in the high-temperature operation of a stove with 60 x 60 mm passages the heating surface of each stove supplying blast for a 1,033 m^3 standard blast furnace can be reduced to 19,300 m^2.

If, however, the operational conditions of the first type chequer brickwork (temperature of combustion products at the entry into brickwork = 1,250°C, and the temperature of the cold blast = 150°C) are applied to the stoves of the 1,033 m^3 blast furnace, each of which has a heating surface of 21,462 m^2, then the following changes will result: the temperature of hot blast will rise to 1,020°C, the drop of hot blast temperature will be 196°C, and the temperature of combustion products leaving the stove will fall to 280°C.

The operation of stoves at this high temperature will require an increase in the capacity of the burner, and involve an increase in the consumption of blast-furnace gas from 25,100 nm^3/h of gas with a calorific value of 918 cal/m^3 to 35,850 nm^3/h of gas with a calorific value of 950 cal/m^3 ; in addition, for the top stages of the chequer brickwork, for the dome and the flame flue, a refractory must be used which under a load of 4 kg/cm^2 does not soften at a temperature below 1,350°C.

The use of a well-cleaned gas for heating to stoves, and the control of dome temperature eliminates the possibility of choking the chequer channels with slag, or of melting the brickwork. However, with the introduction of high-temperature operation, the differences between the beginning and the end of the gas and blast cycles grew larger, with the result that the choking of passages with fragments of brick became more frequent. If the channels run the whole height of the stove, a localized blocking of a channel causes the failure of its entire length. The considerable length of the channels renders their cleaning a too difficult and labor-consuming manual operation.

The characteristics of the second variant are better than those of the first and third types of chequer brickwork though, as in all single-stage types, the brickwork at its lower levels is not used to the full advantage. In the top levels, owing to the high temperature of combustion products, gases flow with a high velocity rendering the coefficients of heat transfer through radiation and convection very high. As they descend, the gases cool down, their volume grows smaller, velocity falls, and the intensity of heat transfer decreases. However, as the mass and the heating surface of the brickwork are the same throughout, it is obvious that the top levels are overloaded while the bottom levels are almost idle. For this reason the adoption of smaller (45 x 45 mm) channel sections fails to remove all the shortcomings of single-stage types of brickwork with through-channels.

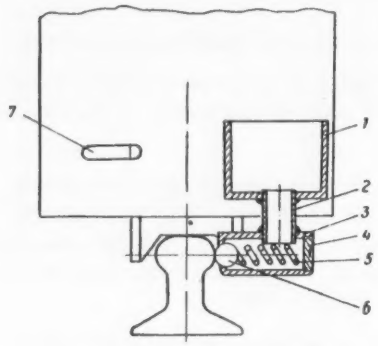
In view of foreign experience with blast-furnace hot blast stoves, it is necessary to adopt the more modern single- and two-stage brickworks using form bricks with horizontal channels. This will enable the heat transfer in the brickwork to be increased, and the relative size of hot blast stoves to be reduced.

AUTOMATIC LUBRICATION OF CRANE RUNWAYS

Ya. S. Rapoport

Stalin Metal Works

The lubrication of the side faces of crane rails ensures the complete elimination of friction between wheel flanges and rails, increases the service life of the wheels and runways of electric travelling cranes many times, and completely eliminates oblique running of crane bridges, thus improving the operational conditions of all parts of the machine. This has been confirmed by the results obtained in the operation of the automatic crane-runway lubricating device used in the sheet-rolling shop of our works.



Automatic crane runway lubricating device.

The device (see Fig.) consists of a lubricant container 1, a tube 2, and a lubricating chamber 3; the lubricating chamber is closed by lid 4, and contains a spring 5, and a ball 6. The container is filled with a thick lubricant (solidol) which enters the lubricating chamber through the tube and remains there in contact with the ball. The ball is also in contact with the rail and when the crane traverses the track, this ball applies lubricant to the side face of the rails. The device is carried on the wheel casing. The hole 7, cut in this casing, enables the device to be fitted in such a manner that the ball is in the same plane as the internal surface of wheel flanges. A lubricating device is fixed on either side of the wheel.

As soon as the wheel flange approaches the rail, the ball touches the side face of the rail and applies the lubricant. If the crane operates in temperatures below freezing point, the lubricant is thinned with kerosene (10-20%).

The device for lubricating crane runways is very simple and easy to use.

ALL-UNION CONFERENCE OF STEELMAKERS.

The All-Union Conference of Steelmakers was held in May, 1957 in Sverdlovsk with more than 800 members - representatives of plants, scientific research, planning and educational institutions and party and social organizations. An active contribution was made to the work of the Conference by representatives of the peoples' democratic countries, the Chinese Peoples' Republic and the Korean Peoples' Democratic Republic. The Conference discussed various questions of developments and improvements in the steelmaking field: improvements in the design of steel melting units, use of oxygen, the technology of melting and casting steel, the part played by refractories in steel production, application of vacuum technology in the production of steels and alloys, continuous casting of steel, etc.

Much preparatory work preceded the Conference. All reports were previously sent to Conference members. This enabled the discussions of topical steelmaking problems to be commenced immediately.

V. S. Bychkov opened the Conference and noted that the wide exchange of first class experience and, in particular, All-Union Conferences of iron and steel men, in many ways, contributes to an increase in metal production, an improvement in the productivity of labor, a reduction in costs and improved quality.

A. F. Myrtsymov came forward with a long report on the basic trends in steelmaking developments at iron and steel plants and on the problems of further increasing steel output and improving quality.

The speaker pointed out that in recent years, in the Soviet Union, workers in the fields of ferrous metallurgy had achieved considerable success in raising metal output and improving the efficiency of productive resources. The U. S. S. R. holds first place in Europe and second in the world in the production of ferrous metals. Steel output in 1956 reached 48.6 million tons. About 90% of all steel in the U. S. S. R. is produced in open hearth furnaces.

A characteristic feature of open hearth development in recent years was a further increase in furnace capacity together with improvements in furnace design.

In 1956, the Voroshilov plant began to build two 500-ton open hearth furnaces. In view of the high productivity and operating economy of large furnaces, they are planning to base their furnace building mainly on the 250-ton and 500-ton capacity open hearth furnace in future.

The technical and economic performances of our furnaces are markedly superior to those of foreign furnaces. Thus the hourly productivity of the 370-ton furnaces at Kuznetsk and Magnitogorsk is 32 to 34 tons while furnaces of approximately the same capacity in the U. S. A. have an hourly production of about 25 tons.

The speaker dwelt in some detail on the use of oxygen in steelmaking. In 1956, about 20% of all open hearth steel was produced with oxygen. In future, it is intended to commission new oxygen plants at a number of iron and steel plants, in particular, at the Dzerzhinsk, Krivoi Rog and Chelyabinsk plants.

At some plants, experiments were carried out on the blowing of hot metal with oxygen with the object of reducing its silicon content. The trials proved to be promising. This method of treating hot metal must be widely introduced in steel production.

A marked rise in steel output is due to the use of basic refractories in open hearth furnace linings. In 1956, more than 250 furnaces in iron and steel plants were equipped with magnesite-chrome roofs. It is intended to installbasic roofs on all open hearth furnaces during 1957 to 1958. The change over of open hearth furnaces to cold, high calory gas firing has had a marked effect on production. The use of this type of fuel enables furnace construction to be simplified.

In 1955 to 1956, three open hearth furnaces at the Red October plant were put on natural gas firing. In the present Five-Year Plan, the open hearth furnaces of a number of southern plants will go over to natural gas firing.

The speaker surveyed the operation of open hearth furnaces. The productivity of labor and other technical and economic operational factors of southern plants are lower than those of the Magnitogorsk and Kuznetsk combines. Thus, the productivity of labor per workman in 1956 at Magnitogorsk was 2980 tons while, at the Voroshilov and Kirov plants, it was 1720 and 1404 tons respectively. This is evidence of the fact that there are great possibilities for increasing the output of steel in the open hearth shops of the southern plants.

Electric steelmakers, in recent years, have given a marked impetus to the production of electric steel, have laid the foundations for the production of increasing tonnages of difficult steels, have increased the rate of melting by blowing the molten bath with oxygen and have mastered the technique of treating metal under vacuum. The planning organizations and plants, however, have made little effort to improve the design and increase the capacity of electric steel melting furnaces which are still less than the capacities of foreign electric furnaces. In the near future, it is essential to push ahead with the building of 60 to 80 ton electric furnaces and to equip some of the furnaces with electro-magnetic stirring devices.

Analyzing converter production, comrade Myrtsymov pointed out that oxygen has recently been introduced for blowing the bath in converters at the Petrov plant. In this connection, the speaker stated that the introduction of this process had been delayed because of the low lives of converter linings. The refractory industry must satisfy the demands of the steelmakers for high grade stable refractory materials.

Apart from the achievements in steelmaking plants, the report also mentioned a number of material defects which exist at present.

At many plants, furnace down time is considerable. Thus, in 1956, down time in open hearth shop No. 3 at the Dzerzhinsk plant was 15.4%, in No. 1 shop at Makeevka it was 14.4% and in the open hearth shops at Chelyabinsk it was 14.2% while down time at the Magnitogorsk and Kuznetsk combines was 7.8 and 6.6% respectively.

The prolonged periods of furnace stoppages are explained by defects in production organization, unsatisfactory furnace maintenance, bad repair organization and also "bottle necks" in certain parts of the shop.

There is a great difference in the number of workers serving open hearth furnaces of a given capacity at different plants. Thus, at Magnitogorsk, there are eighty men serving a furnace, at Kuznetsk, 87, at Zaporozhstal, 90 and, at Nizhne Tagil, 120 men.

This bears witness to the fact that the managements of some plants and shops are not working hard enough on the mechanization and automation of production processes and on the improvement of production organization and do not adequately disseminate the experience of the leading plants.

After the plenary sessions, the open hearth, electric furnace and converter sections went to work to discuss the various questions associated with steelmaking from all angles. The Stalproekt (State Steel Plan) design for a new machine for cleaning the slag pockets of open hearth furnaces came in for brisk criticism in the open hearth section. The section passed a resolution regarding the necessity of designing a new machine of simpler design with better maneuverability and easier control.

Among other subjects, the members of the electric steelmaking and converter sections discussed the duplex shop in which provision is made for oxygen blast converters and electric furnaces. The section recorded that the Gipromez (State Institute for Planning Engineering Plants) plan for a duplex shop does not fulfill essential requirements and is not satisfactorily drawn up. The Conference recognized that it was essential, in the near future, to try out the duplex process (converter-electric furnace) at the Chelyabinsk iron and steel plant.

The Conference also discussed the question of organizing further steelmakers' conferences. It was decided that, in future, All-Union Conferences should be called annually to discuss the most topical problems of steel production. All-Union Conferences should be preceded by a conference of subject specialists in steel production.

The All-Union Conference of Steelmakers passed a unanimous resolution outlining the basic directions in which steel production must develop.

I. Polyak
O. Sokolov

Fundamental questions which were discussed at the All-Union Conference of Steelmakers will be reviewed in our journal.

Some reports of the Conference are published below.

EFFECTIVENESS OF THE USE OF OXYGEN IN STEEL PRODUCTION

V. A. Rozhkov

The use of oxygen in the production of steel will permit nation-wide savings in fuel and investment, and also lead to a reduction in the expenses of the steel-manufacturing industry.

The quality of steel produced in converters operating on oxygen blast is the same as that of the metal produced by the open-hearth process. The use of oxygen creates favorable conditions for a wider application of the converter process which requires a much smaller capital investment, and is easier to run than the open-hearth process. In open-hearth and electric furnaces, oxygen accelerates the steel melting process. This is accompanied by savings in the cost of fuel (electric power, electrodes) and in subsequent processing.

The open-hearth process occupies a predominant position in the total output of steel and we shall therefore first consider the economic implications of the use of oxygen in open-hearth furnaces. This paper gives a technological-economical analysis of the use of oxygen in heating open-hearth furnaces at the "Zaporozhstal" works and the Nizhny Tagil Metal Combine. The study is based upon the comparison of the production of the same quantity of steel in furnaces using oxygen, and in a large number of normal furnaces.

The open-hearth furnace shop at the "Zaporozhstal" works is equipped with furnaces of 185 ton nominal capacity. The furnaces of the open-hearth furnace shop No. 2 at the Nizhny Tagil Metal Combine have 370 ton furnaces. The "Zaporozhstal" works have used oxygen for boosting the steel melting process since 1953, and the Nizhny Tagil Combine since 1956.

Both works produce about the same amount of standard grade steel, mainly 3 kp steel (40-45% of the total plant output) and, in addition, "Zaporozhstal" produces low-carbon steels (up to 0.12-0.08%), while the No. 2 melting shop of the Nizhny Tagil Combine manufactures high-carbon steels (about 0.45 and 0.70%).

The main operational data of the "Zaporozhstal" and N. T. M. C. shop No. 2 are given in Table 1. The data regarding the operation of the "Zaporozhstal" furnaces without oxygen are for April 1954, and those of N. T. M. C. for the fourth quarter of 1955. The data on furnace operation with oxygen refer to the use of oxygen for boosting the melting process.

TABLE 1

Data on the Operation of 185-ton Furnaces at the Zaporozhstal Works, and the 370-ton Furnaces at the Nizhny Tagil Combine, With and Without Oxygen.

Characteristics	"Zaporozhstal"			N. T. M. C.		
	without oxygen	with oxygen		without oxygen	with oxygen	
	April 1954	April 1954	first half-year 1956	fourth quarter 1955	March-July 1956	August-November 1956
Stoppages in furnace operation, in % of calendar period, total	10.1	10.1	11.4	12.4	11.6	13.0
Including:						
hot	6.0	6.0	6.8	4.9	4.2	5.5
cold	4.1	4.1	4.6	7.5	7.4	7.5
Duration of melting process, in hrs	9.31	7.70	7.66	11.67	10.17	9.89
Consumption of standard fuel per 1 ton of steel, in kg	176	150	154	137	113	115
Oxygen consumption per 1 ton of steel, in m^3	—	38.7	36.7	—	28.9	—
Average life of magnesite-chromite roof in no. of charges	417	415	497	334	331	331
Average time taken for cold repairs, in days	8.44	—	7.76	7.18	6.67	7.41

An examination of operational characteristics of furnaces running with and without the supply of oxygen into the flame shows that hot repairs are slightly higher when oxygen is used; cold repairs show practically no changes since no drop in the service life of refractory lining is observed.

The daily output of the melting shop increased in the works under consideration by 15-20%, and the furnace output during an actual furnace-hour improved by 16-19%. However, this increase in productivity cannot be attributed to the use of oxygen only; the increase in steel output is also due to the increased weight of the charge, and other factors. The relevant calculations show that the increase in the output of the "Zaporozhstal" and N. T. M. C. melting shops, due to the use of oxygen is about 15-16%.

In proportion to the quantity of oxygen supplied to the shops, the increase in productivity due to the use of this gas is inadequate. A statistical examination indicates that the length of individual stages of the melting process can be considerably reduced. Any reduction of charging time is at present prevented by the inadequate capacity of the charging boxes, and a reduction of heating time depends on speeding up the preparation of working doors and other operations connected with the pouring-in of pig iron. Furthermore, hold-ups in the supply of pig iron must be removed. In both works a reduction in melting and handling time of a charge is to a considerable extent prevented by the inadequate capacity of casting bays.

Time studies of melting processes show that the removal of these bottlenecks can increase the output of melting shops by at least 20-25% as compared with the time taken when no oxygen was used. This stresses the great importance of the technical and planning work which is necessary to melting shops intending to use oxygen. In the case of inadequate or slow preparation of all sections of the shop for a sharp increase in furnace output, the intensification of the melting process by means of oxygen will prove economically inefficient.

Comparison of individual stages of the melting process shows that the use of oxygen in the 185-ton furnaces at "Zaporozhstal" effected a considerable reduction in the length of the charging and heating periods, while in the 370-ton furnaces at N. T. M. C. the length of all stages of the process was reduced by about the same amount.

Any further reduction of the charging and heating time in the conditions prevailing in the melting shops is to some extent limited by technical and organization problems. It therefore seems justified to assume that the removal of "bottlenecks" will result in the reduction of those stages of the melting process which are characterized by heavy thermal loads. It should be pointed out, with regard to the supply of oxygen, that the 370-ton open-hearth furnaces of melting shop No. 2 at the N. T. M. C. are in a considerably better position; owing to the larger charge of these furnaces, their oxygen consumption per 1 m^2 of the bottom area is one and a half times higher than that of the 185-ton furnaces at the "Zaporozhstal" works. This fact, together with the special properties of the steel produced in the N. T. M. C. furnaces, enables a more effective use of oxygen to be made during the actual ("technological") melting process than it is possible with the "Zaporozhstal" furnaces.

At the "Zaporozhstal" works the increase in productivity of the furnaces was achieved by the use of 36.7 m^3 of oxygen per 1 ton of steel, while at the N. T. M. C. works the corresponding figure was 28.8 m^3/ton of steel.

Tables 2 and 3 give data showing the changes in production costs effected by the use of oxygen in the 185-ton furnaces at "Zaporozhstal", and the 370-ton furnaces at N. T. M. C. The changes are given for each stage of the melting process, and enable the conclusion to be drawn as regards the effectiveness of the use of oxygen during the first part of the melting process – before pig iron is added – and during the second part, the so-called "technological" part – from the adding of pig iron to the end of the process.

The figures of Table 2 regarding the 185-ton furnaces at "Zaporozhstal" show that although the lengths of the charging and heating periods are as yet not sufficiently reduced, the use of oxygen during these stages of the melting process is economically effective, since about 1/3 of the total oxygen consumed in melting a charge falls in these periods. The length of the melting process is thereby reduced by 7.8%, and savings are also achieved in fuel consumption and shop overheads. The length of the "technological" stages of the melting process, during which the fuel consumption amounts to almost 2/3 of the total consumption, is reduced by only 7.2%, and the savings in fuel and overheads fail to balance the cost of oxygen, which results in some overexpenditure.

TABLE 2

Effectiveness of Oxygen Applied into the Flame in the Operation of 185-ton Furnaces at the "Zaporozhstal" Works (first half-year 1956)

Stages of melting process	Duration of process, hrs		Thermal loads, million cal/hr.		Consumption of standard fuel, kg/ton		Oxygen consumption m³/ton	Saving (–), overconsumption (+), rub./ton			
	Without oxygen	With oxygen	Without oxygen	With oxygen	Without oxygen	With oxygen		Oxygen	Fuel	Shop overheads	Total
Preparation	0.36	0.36	22.0	20.7	5.7	5.3	—	—	—0.05	—	—0.05
Charging	1.30	1.13	28.6	32.0	26.8	26.0	6.8	+0.87	—0.04	—0.19	+0.64
Heating	1.47	0.94	27.4	27.6	28.9	18.7	5.7	+0.72	—1.40	—0.59	—1.27
Adding pig iron	0.27	0.30	22.0	22.5	4.2	4.8	1.8	+0.23	+0.08	+0.03	+0.34
Melting	3.39	3.05	24.0	23.6	58.5	51.9	18.4	+2.34	—0.92	—0.38	+1.04
Refining	2.23	1.88	22.8	23.7	36.5	32.1	4.0	+0.51	—0.58	—0.39	—0.46
Total	9.02	7.66	24.8	25.2	160.6	138.8	36.7	+4.67	—2.91	—1.52	+0.24
Including:											
Charging and Heating	2.77	2.07	28.0	31.5	55.7	44.7	12.5	+1.59	—1.44	—0.78	—0.63
Pouring pig iron, melting and refining	5.89	5.23	23.5	23.6	99.2	88.8	24.2	+3.08	—1.42	—0.74	+0.92

TABLE 3

Effectiveness of Oxygen Supplied into the Flame in the Operation of the 370-ton Furnaces at the Nizhny Tagil Metal Combine

Stages of melting process	Duration of process, hrs.		Thermal loads, million cal/hr.		Consumption of standard fuel, kg/ton		Oxygen consumption m³/ton	Saving (—), overconsumption (+), in rub./ton			
	Without oxygen	With oxygen	Without oxygen	With oxygen	Without oxygen	With oxygen		Oxygen*	Fuel	Shop overheads	Total
Preparation	0.55	0.58	20.9	21.5	4.4	4.8	—	—	+0.55	+0.02	+0.07
Charging	2.18	1.87	27.9	28.8	23.4	20.7	7.0	+0.99	—0.34	—0.24	+0.41
Heating	1.82	1.45	28.0	27.3	19.6	15.2	4.7	+0.67	—0.56	—0.29	—0.18
Adding pig iron	0.35	0.37	26.0	24.0	3.5	3.5	1.3	+0.17	—0.08	+0.02	+0.11
Melting	4.27	3.47	27.3	25.8	44.8	34.4	14.3	+2.00	—1.44	—0.63	—0.07
Refining	2.50	2.43	25.1	25.6	24.1	23.9	1.6	+0.22	—0.05	—0.06	+0.11
Total	11.67	10.17	26.7	26.2	119.8	102.5	28.9	+4.05	—2.42	—1.18	+0.45
Including:											
Charging and heating	4.00	3.32	28.0	28.1	43.0	35.9	11.7	+1.66	—0.90	—0.53	+0.23
Pouring pig iron, melting and refining	7.12	6.27	26.5	25.6	69.4	60.7	17.2	+2.39	—1.57	—0.67	+0.15

* Without taking into account starting losses, and losses of oxygen.

The data on the advantage of using oxygen in the 370-ton furnaces at the N. T. M. C., given in Table 3, show an opposite result. Here, the use of oxygen proved to be most effective during the melting and refining stages; the shortening of these periods enabled the total length of the process to be reduced by 7.3%, while the reduction of the charging and heating periods renders the melting process 5.8% shorter.

The conclusion resulting from the examination of changes in the production costs of steel at the "Zaporozhstal" and N. T. M. C. works is that the available oxygen is used more efficiently during charging and heating, provided the length of these periods is substantially reduced by various technical measures and the improvements in organization; and during the technological part of the melting process, if the obtainable degree of enrichment of air leads to a substantial reduction of the charging and heating time. It must, therefore, be determined by experience whether it is more profitable to add oxygen only during the charging and heating periods, or during the technological periods of the melting process.

In the operation of the 185-ton furnaces at the "Zaporozhstal" works, the addition of oxygen had no appreciable effect upon the loss of metal and ore in the charge. In the case of the 370-ton furnaces at N. T. M.C., however, the use of oxygen effected a cut in the consumption of ore, from 176 to 144 kg per ton of open steel, and from 149 to 121 kg per ton of dead steel, accompanied by an increase in pig iron consumption amounting to 20 kg per ton of steel. This indicates the positive effect of oxygen during the melting period, especially when the percentage of oxygen is high; apart from increasing the heating effect of the flame and reducing the heat losses, it also has a considerable chemical effect upon the bath.

Calculations show that in the conditions prevailing at the "Zaporozhstal" works, the investment involved in the supply of oxygen into the flame, made upon the recommendation of the TsNIIChM, is justified by the saving at the same works in capital investment for other purposes, as it increased the output of the furnaces by about 25%.

The investigation of the organization and of the technical characteristics of furnace operation showed that because of the existence of bottlenecks in melting shops, the increase in the efficiency of open-hearth furnaces achieved in 1956 by the use of oxygen failed to reduce the production costs of metal more than would be achieved by the construction of new furnaces. The boosting of the steel melting process by the use of oxygen must therefore be preceded by the elimination of bottlenecks in those auxiliary sections preventing an increase in the efficiency of open-hearth furnaces.

Furnaces with an output twice as high consume almost 25% less oxygen per ton of steel produced. An increase of the charge alone produces an increase in output of 45-50%; it is therefore necessary, wherever possible, first to increase the charge, and then to introduce the use of oxygen for boosting the process.

The use of oxygen in only some stages of the melting process enables an increase of 8-10% in the output of furnaces to be achieved with a considerably smaller relative oxygen consumption (Tables 2 and 3). This enables oxygen to be used efficiently in melting shops where the condition of auxiliary sections and the elimination of bottlenecks would not secure a higher increase in output.

Thus, in the melting shops now in operation, there is a wide field for the efficient boosting of the melting process by the use of oxygen; these possibilities must be utilized with the actual conditions of each shop taken fully into account.

PRODUCTION OF KILLED CARBON STEEL WITHOUT PRELIMINARY DEOXIDATION IN THE FURNACE

A. I. Borodulin

Since January 1956, all high carbon steels, including rail steels, have been tapped at the Kuznetsk iron and steel combine without preliminary deoxidation by blast furnace ferrosilicon in the furnace.

Prior to going over to the large scale production of metal without the use of blast furnace ferrosilicon, the Kuznetsk combine, together with the Siberian Metallurgical Institute, undertook much research work to study the influence of the new method of deoxidation on metal quality and cost, tap-to-tap time, silicon and manganese losses in the furnace and in the ladle, variation in slag and metal composition during the process of deoxidation, gas content (oxygen and hydrogen) and non-metallic inclusions in the steel, mechanical properties and macrostructure, and consumption of deoxidizers.

Trial heats were produced in basic 190- and 380-ton open hearth furnaces fired with a mixture of three gases. The steel was melted in accordance with existing technological instructions, with the exception of deoxidation which was carried out with various modifications.

Table 1 presents details of trial heats of rail steel in 380-ton furnaces with various methods of deoxidation.

The average period of deoxidation was practically the same (10 to 11 minutes) for all groups of steels deoxidized without blast furnace ferrosilicon. It should be noted that, even at the present time, when all high carbon steel is produced without preliminary deoxidation, this period remained practically unchanged and, in November, 1956, it was 10.4 minutes. There is, however, a basis for supposing that when the mechanization of taphole opening has been achieved, the period of deoxidation will be cut to 5 to 6 minutes.

Manganese losses, during deoxidation, depend on the amount of deoxidizers and the manner in which they are added, on the physical and chemical condition of metal and slag, on the periods of deoxidation and tapping and on other factors. However, practically constant conditions of carrying out deoxidation and tapping for each group of heats made it possible to show the effect of basic factors on manganese losses.

As will be seen from Table 1, average manganese loss (as a percentage of what was initially added) when blast furnace ferrosilicon was used, varied between 12.7 and 18.2% while, when deoxidation was effected with ferromanganese alone, the manganese loss was 22.1% and, in cases where there was some delay in deoxidizing, manganese losses were about 27%.

The way in which manganese losses increase as the period of deoxidation is prolonged is shown in Table 2.

In order to cut manganese losses, the deoxidation period must not exceed 5 to 8 minutes. As the processing of experimental data showed, the FeO content of the slag prior to deoxidation and also the manner in which FeMn is added to the bath (whether in one or two portions) does not materially affect the extent of Mn losses.

In heats analyzed in November, 1956, ferromanganese losses reached an average of 17%, being 13.5% with deoxidation periods of up to ten minutes and up to 25% with periods of over ten minutes. Thus, the deoxidation of rail steel without blast furnace FeSi is accompanied by a 3.9% increase in manganese losses, as compared with the introduction of ferromanganese after blast furnace ferrosilicon and there is a 9.4% increase in manganese losses when blast furnace ferrosilicon is added after the ferromanganese. This corresponds to a 300 to 500 kg increase in the consumption of FeMn per 380-ton heat or an increase of 0.86 to 1.32 kg per ton of steel produced.

Total silicon loss in the furnace and in the ladle for heats deoxidized by blast furnace FeSi varies from 22.4 to 34.1% while, when the steel is deoxidized in the furnace with FeMn only, the Si loss has an average variation of 5.5 to 8.8%. The small average Si loss in the ladle when the steel is deoxidized in the furnace with FeMn alone bears witness to the fact that, without preliminary deoxidation of the metal with blast furnace FeSi, the Si loss in the ladle is not increased.

TABLE 1

Characteristics of Trial Heats of Rail Steel

Characteristics	With blast furnace FeSi			Without blast furnace FeSi	
	Type of rails				
	R-43		R-50	R-43	R-50
Amount of blast furnace FeSi added, tons per heat	5.6	3.9	3.8	—	—
Number of heats	36	20	49	89	67
Addition of deoxidizers in t:					
FeMn	4.27	4.10	4.70	4.60	5.20
blast furnace FeSi	5.64	3.91	3.80	—	—
45% FeSi	1.01	1.21	1.20	1.89	1.94
Additions in %:					
C into furnace	0.08	0.08	0.09	0.08	0.09
Mn*	0.82	0.79	0.88	0.88	0.99
Si*	0.20	0.15	0.12	—	—
Si into ladle	0.12	0.14	0.14	0.22	0.23
Period (in mins) of:					
deoxidation (average)	24	17	23	10	11
tapping	10	10	10	11	10
Composition of metal (ladle sample), %:					
C	0.70	0.70	0.74	0.71	0.74
Mn	0.74	0.76	0.80	0.73	0.82
Si	0.21	0.22	0.21	0.21	0.21
P	0.022	0.025	0.021	0.018	0.022
S	0.028	0.029	0.033	0.033	0.033
Total loss of deoxidizer elements, % amount initially added					
Mn	18.2	12.7	17.2	22.1	22.1
Si	34.1	26.0	22.4	5.5	8.8
Wt. of liquid steel, tons	381.0	381.6	381.0	383.1	380.0
Consumption of ferroalloys, kg per ton of metallic charge:					
FeMn	11.2	10.7	12.2	12.0	13.3
Blast furnace FeSi	14.8	10.3	9.9	—	—
45% FeSi	2.65	3.21	3.14	4.60	5.0
Content in metal, %					
C + 0,25 Mn	0.89	0.89	0.93	0.89	0.94
Mechanical Properties					
yield point, σ_S kg/mm²	51.9	54.3	55.5	52.0	54.0
tensile strength σ_B kg/mm²	87.2	88.4	90.5	88.5	93.0
elongation δ, %	5.6	5.7	5.3	5.5	7.8
reduction of area, ψ,%	8.3	9.3	9.1	9.0	13.6
Brinell hardness, H_B	246	252	260	253	266
deflection, mm	47.1	42.7	38.0	45.0	39.0

As the test showed, the addition of 0.22 to 0.23% Si to the ladle with such a deoxidation technique makes it possible to obtain 0.21% Si in the ladle sample.

TABLE 2

Relationship Between Manganese Losses and the Period of Deoxidation

Type of rails	Deoxidation period in minutes	Number of heats	FeO content prior to deoxidation, %	Mn loss
R-43	5-10	36	8.5	21.3
	11-15	29	8.7	22.9
R-50	5-10	54	9.4	21.5
	11-15	31	9.0	23.9

The variation in phosphorus and sulfur contents during deoxidation and their contents in the finished steel is of great interest. In those heats deoxidized in the furnace with ferromanganese only, P is 0.006 to 0.009% less and S 0.004 to 0.006% less, compared with metal which has been deoxidized with blast furnace FeSi.

Steel produced without preliminary deoxidation is cleaner as regards hydrogen and oxygen.

A comparison of the average consumption of FeMn and 45% FeSi (see Table 1) shows that, when rail steel is produced without blast furnace FeSi, the FeMn consumption is increased by 0.8 to 1.3 kg per ton while the consumption of 45% FeSi is raised by 1.39 to 2.0 kg per ton. In addition to this, however, the consumption of blast furnace FeSi is reduced by 9.9 to 14.8 kg per ton. The reduction in cost per ton of rail steel for R-43 type rails produced without blast furnace FeSi was 2.6 to 4.9 rubles per ton and, for R-50 type rails, 2.6 rubles per ton.

When the period of deoxidation is prolonged beyond fifteen minutes, the consumption of FeMn is increased by 1.7 to 2.2 kg per ton as a result of which the saving in the cost per ton of steel is reduced to 1.4 to 3.7 rubles for R-43 rails and to 1.6 rubles for R-50 type.

Thus, it is economically sound to melt steel without preliminary deoxidation with blast furnace FeSi. When the period of deoxidation is prolonged, the consumption of FeMn is increased and the economic effect is diminished.

Table 1 shows that the chemical composition of the metal of the trial heats is the same. A certain improvement is observed in the mechanical properties of the metal produced without preliminary deoxidation. A specially marked improvement of the mechanical properties of the steel was noted in the production of R-50 type rails. The rails are more ductile and, at the same time, harder. The macrostructure of the finished rails in both cases of deoxidation was good and was considered to be first class.

In the Kuznetsk steelmaking shops more than three million rubles were saved by reduced consumption of ferroalloys in 1956 compared with 1955. If we take into account reduced fuel consumption accompanied by increased steel production by virtue of a shorter deoxidation period, the economic effect will be still greater.

The new method of deoxidation enabled the Kuznetsk combine to reduce tap-to-tap time by an average of thirteen minutes on killed carbon steel production, to lower steel costs by 2 rubles 6 kopeks to 4 rubles 9 kopeks per ton, to improve the mechanical properties of the steel and the yield of top grade material. In addition, considerable blast furnace capacity was released for the production of pig iron for steelmaking.

NEW GRADES OF LOW ALLOY STEELS

M. B. Pridantsev and G. L. Livshits

TsNIIChM

One of the certain ways of saving metal and increasing the life of structures and machines is the use of low alloy steel of increased strength in place of common carbon steels St. 3, St. 4, 15, 25, and others.

As compared with carbon steel, low alloy steel not only has higher strength properties in the hot-rolled state, but also a reduced tendency to aging, better cold brittleness characteristics (especially in heavy sections), and a better resistance to abrasive wear. Low carbon steels intended for heavy-duty welded structures possess good welding qualities.

The use of low alloy steels in place of carbon steel grades leads to an economy in metal; structures, machines and equipment in which low alloy steels are used can be lighter than those made of carbon steel. For example, the use of low alloy steels in the building industry, shipbuilding, the construction of motor and other vehicles (including railroad rolling stock), the construction of gas and oil pipelines, in road construction and in the building of cranes and excavators, enables the weight of structures to be reduced by 15-30%.

The carbon content of steels intended for heavy-duty welded structures is limited to ensure a good or satisfactory weldability, and to provide the required technological qualities (bending, pressing, etc.), and operational properties.

Low alloy steels with high welding properties include steels with increased impact strength at sub-freezing temperatures, reduced sensitivity to stress concentration and spreading of cracks, as well as a reduced tendency to brittle fracture – even in the case of heavy sections.

The existence of these properties, and also the moderate hardness of the welding zone after hardening caused by the welding process (which is due to the low carbon content), prevent the occurrence of cold cracks and brittle fractures in welded structures. Low alloy steels of limited weldability include steels with a reduced tendency to brittle fracture, limited by the thickness of the section. The maximum thickness of sheets or sections for which low alloy steels of this type can be used in the hot-rolled state depends on the complexity of the welded structure, and on the load to which it is subjected, as well as on the method of welding applied. It should be pointed out that hot-rolled dead carbon steel is a steel of limited weldability, even if it has been deoxidized by aluminum; it cannot, therefore, be used for heavy-duty welded structures as a plate exceeding 20 mm in thickness.

Low alloy steels also include the materials used in reinforced concrete structures; although the weldability of these steels is limited by the slightly higher carbon content, it is still fully adequate for this purpose and, what is more important, is combined with high strength characteristics.

The substitution of carbon steel by low alloy grades can only be effective when the difference in the cost of both materials is justified by savings in quantity.

The economic efficiency of each grade of low alloy steel is in the first instance determined by the alloying elements it contains. Such economic alloying elements include silicon, manganese and chromium.

The need to keep the carbon content low in weldable steels calls for the use of manganese-silicon 14 or 17 (according to the manganese and carbon content of the steel) in melting steels with more than 1% Mn. These alloying materials are made by an electric-furnace process and are in short supply. The most important task therefore is to widen the industrial application of steel with considerable carbon content, which enables the use of the blast furnace ferromanganese in the deoxidation process and to reduce the use of low carbon ferromanganese and manganese-silicon.

The following grades of low alloy steels are already widely used in the U. S. S. R. : 10G2, 19G, 14KhGS, MK, BNL2, SKhL1, NL2, SKhL4, MS1, 25GS, 18G2S.

Grade of steel	Chemical analysis, in %					
	C	Si	Mn	Cr	Ni	Cu
15GS	0.12—0.18	0.70—1.00	0.90—1.30	≤0.30	≤0.30	≤0.30
18G2S	0.14—0.23	0.60—0.90	1.20—1.60	≤0.30	≤0.30	≤0.30
25G2S (25GS)	0.20—0.29	0.60—0.90	1.20—1.60	≤0.30	≤0.30	≤0.30
10G2SD (MK)	≤0.12	0.80—1.10	1.30—1.65	≤0.30	≤0.30	0.15—0.30
14KhGS	0.11—0.17	0.40—0.70	0.90—1.30	0.50—0.80	≤0.30	≤0.30
30KhG2S	0.26—0.35	0.60—0.90	1.20—1.60	0.60—0.90	≤0.30	≤0.30
14khGSN	0.11—0.17	0.40—0.70	0.90—1.30	0.20—0.60	0.80—1.30	≤0.30
10KhG2SN	≤0.12	0.50—0.80	1.20—1.60	0.20—0 60	0.80—1.30	≤0.30
10KhGSND(MS 1)	≤0.12	0.80—1.10	0.80—1.20	0.30—0.50	1.00—1.30	0.30—0.50
10KhSND (SKhL4)	≤0.12	0.80—1.10	0.50—0.80	0.60—0.90	0.50—0.80	0.40—0.65
15KhSHD (SKhL1, NL1, NL2)	0.12—0.18	0.40—0.70	0.40—0.70	0.60—0.90	0.30—0.60	0.20—0.40
12KhG (BNL2)	≤0.14	0.25—0.50	0.40—0.80	0.40—0.70	≤0.30	≤0.30
12 KhGN	≤0.14	0.20—0.40	0.90—1.30	0.20—0.60	0.80—1.30	≤0.30
10KhG2N	≤0.12	0.20—0.40	1.20—1.60	0.20—0.60	0.80—1.30	≤0.30
15KhGN	0.12—0.18	0.20—0.40	0.90—1.30	0.20—0.60	0.80—1.30	≤0.30
14KhG2N	0.11—0.17	0.20—0.40	1.30—1.70	0.20—0.60	0.80—1.30	≤0.30
14G	0.12—0.18	0.20—0.40	0.70—1.00	≤0.30	≤0.30	≤0.30
19G	0.16—0.22	0.20—0.40	0.70—1.00	≤0.30	≤0.30	≤0.30
24G	0.21—0.28	0.20—0.40	0.70—1.00	≤0.30	≤0.30	≤0.30
09G2	≤0.12	0.20—0.40	1.40—1.80	≤0.30	≤0.30	≤0.30
14G2	0.12—0.18	0.20—0.40	1.20—1.60	≤0.30	≤0.30	≤0.30
10GND	≤0.12	0.20—0.40	0.90—1.30	0.20—0.60	0.80—1.30	0.50—0.80
14GND	0.11—0.17	0.20—0.40	0.90—1.30	0.20—0.60	0.80—1.30	0.50—0.80
10KhNDP*	≤0.12	0.20—0.40	0.30—0.60	0.50—0.80	0.30—0.60	0.30—0.50

* Phosphorus content of this steel is 0.08-0.15%.

The application of low alloy steels in this country is still inadequate and is lower than their use abroad.

The Table gives the chemical analysis of low alloy steels for various purposes, as given in the GOST-specification 5058-57 approved by the Committee of Standards, Measures and Measuring Instruments.

The advantages of the GOST specification over foreign standards are as follows:

1) the chemical analysis of each grade is guaranteed;

2) the content of carbon and alloying elements is specified more closely;

3) the maximum carbon content is lower;

4) the sulfur and phosphorus content is lower.

Low alloy steels are manufactured by a number of metal works in open-hearth furnaces and in converters.

A thorough deoxidation, important as it is for any type of steel, is particularly important in the case of low alloy steels.

Some qualitative characteristics of steel, for example the impact strength at sub-freezing temperatures, bending properties, grain of fracture, sensitiveness to aging, and tendency to the formation of welding cracks, depend to some extent on the quality of deoxidation. In order to prevent hydrogen from getting into the steel, care should be taken that the ferrosilicon added into the ladle is properly heated.

It is also necessary that measures are taken to prevent burning-out of aluminum added into the ladle. It was shown at the "Zaporozhstal" works that it is possible to cut the aluminum consumption in the production of low alloy steel 14KhGS from 0.5 to 0.25 kg/ton of steel. A reduced aluminum content (which must invariably be accompanied by the addition of ferrotitanium) results in an appreciable improvement in the quality of the surface of ingots, and the reduction of waste. Lowering the aluminum content leads to a decrease in waste, due to the lamination of sheets and to the improved quality of surface. The results of acceptance tests show that a lower aluminum content has no adverse effect upon the mechanical and technological properties of sheets and tubes of steel 14KhGS.

After the deoxidation of steel by means of aluminium, an addition of 1-2.5 kg of titanium per 1 ton of steel is made to the metal.

The actual amount of titanium added depends on the grade of the steel and the thickness of the rolled section. More titanium is added when the steel is intended for rolling into heavier sections and plates, while for thinner types the titanium aftercharge is correspondingly smaller.

One of the methods of cutting the cost of low alloy steels is an economy in manganese, effected by adding it only into the ladle (without the use of manganese-silicon in the preliminary deoxidation); the same purpose is served by adding silicochromium in place of ferrochromium and ferrosilicon in making silicon and chromium alloy steels.

In order to avoid considerable differences in the properties of steel at various levels of the ingot, no heating agents with high carbon content may be used in the manufacture of low alloy steels.

A NEW METHOD OF MANUFACTURE OF STAINLESS STEEL

B. A. Shilyaev

Manufacturers of special steel use electric furnaces of 20, 30 and 40 ton capacity, for the production of stainless steel with the use of oxygen.

The method the producers use enables the speeding-up of the melting process, and results in a considerable reduction of the production costs due to the increased use of alloy-steel scrap. At the "Dneprospetsstal" and "Elektrostal" works the cut in the duration of the melting process due to the use of oxygen amounts to 4-4.5 hours while the production costs of 1 ingot ton were reduced by about 300 rub., as compared with those of steel produced without the use of oxygen.

The use of oxygen in melting stainless steel improves the quality of the product and reduces the waste due to flaws and fine cracks.

Improvements in the melting process increased one and a half to two times the life of the lining of electric furnaces, and also enabled a saving in the consumption of chromium from 25 to 10-12%.

At present oxygen is used in melting of practically all grades of stainless steel.

The factors which must be taken into account in selecting charges for oxygen melting are the chemical analysis of the metal, and the quality of the charge. When the charge contains considerable quantities of vanadium, tungsten and niobium as alloying elements of scrap metal, then oxygen should only be used if the loss caused by the burning-out of these metals does not exceed the savings in electric power and overheads. Oxygen should also be applied when the charge contains mixed scrap, and scrap with high carbon and silicon content.

In 1956, at a special training conference of the electric steel makers on the study of processes used in the works of Glavspetsstal for melting stainless steel by means of oxygen, it was found that each works uses a somewhat different method in melting stainless steel 1Kh18N9T. But it was also found that a number of methods used have common features.

The technological and economic characteristics of processes used at various works in melting steel 1Kh18N9T are compared in the Table.

Basic Technological and Economic Characteristics of Processes Used in Melting Stainless Steel 1Kh18N9T in 1956

Manufacturer	Type of process	Capacity of electric furnace, in tons	Consumption of electric power, in kw-hr/ton	Duration of melting process, in hr-min	Total loss of chromium, in %	Loss of titanium, in %	Oxygen consumption, in m^3/ton
"Elektrostal"	With oxygen, without removal of slag	20	400	4-10	10	50	35
	Without oxygen	20	758	6-28	8	50	–
"Dneprospetsstal"	With oxygen, and with the removal of slag	30	426	4-40	14.8	50	30
	Without oxygen	30	692	6-16	10-12	50	–
"Krasny Oktyabr" Chelyabinsk	With oxygen	20	480	4-30	10-15	55	40
	With oxygen used only for oxidation	40	630	5-50	20-25	50	15
KMK	With oxygen used only for oxidation	35	500	5-25	10-11	50	15

On the basis of the study and coordination of the experience of leading manufacturers, the special training conference of electric-steel makers recommend the following standard method in the production of stainless steel with the use of oxygen:

1. The charge must be composed of 60-75% of stainless steel scrap and 15-25% of silicon-steel scrap. In the absence of such scrap, scrap of nickel-chromium steels can be used in order to economize the costly special low-carbon ingots. As a rule, silicon must be introduced into the charge in the form of silicon-steel scrap.

The calculated percentage of chromium in the charge should not exceed 12.5%, and the silicon content should be less than 0.9-1.2%.

In the production of stainless steel containing 0.05-0.07% carbon, the amount of stainless steel scrap added to the charge should be reduced to 40-50%, in order to keep the chromium content within 7-8%.

2. Oxygen must be blown into the molten metal at a pressure of 8-15 atm for about 1-1.5 hours after the furnace has been switched on, and when 50-70% of the charge has melted. The charge can be considered molten when it begins to boil.

3. The oxidation of the metal by means of oxygen must be carried out with great intensity, which means that the lancing must begin when the current is fully switched on, and the furnace must be switched off at a later stage. During the oxidation process, the oxygen must be introduced through a water-cooled nozzle in the roof of the furnace.

4. Ferrochromium must be added in a red-hot state immediately after the oxidation, without first tapping off the slag. This results in a rapid melting of the ferrochromium aftercharge, and in the cooling of intensely hot metal without damage to the furnace lining.

No oxygen is introduced while ferrochromium is added, as this would increase chromium losses through burning.

5. In order to increase the basicity of slag and reduce the loss of chromium, the slag must be deoxidized with crushed or ground chromium-silicon, and the 45 % ferrosilicon mixed with 2-3% of lime. An additional deoxidation of slag is carried out by means of calcium-silicon. Adherance to these suggestions will reduce the total loss of chromium during the melting process to a maximum of 10%.

The refining can be carried out without the prior removal of slag (if the amount of slag is not very great), or else, after removing the slag – if it is deoxidized, and light in color.

6. After the slag has been deoxidized, the metal must be analyzed for chromium content, which serves as a guide for the final correction aimed at obtaining metal with 17-18% Cr.

Nickel is corrected so as to obtain a content of 10-10.3% in the metal intended for sheet rolling, and in the metal intended for tubing – 10.4-10.8%, maintaining a ratio of not more than 1:8 between chromium and nickel.

7. In order to obtain an economy in metallic manganese, the correction for manganese content should be made by adding low-carbon manganese-silicon or low-carbon ferromanganese.

8. In order to keep the loss of titanium at 40-50%, the ferrotitanium must be added under a small quantity of the deoxidized lime slag, 8 to 10 minutes before tapping, while the metal is at high temperature.

If the melting process is conducted in conformity with these suggestions, a melting time of 4.5 hours and power consumption of not more than 450kw-hr/ton can be achieved with 20-40 ton electric furnaces.

This standard process can be used in melting any grade of stainless steel.

In order to obtain ingots with a high surface quality, a temperature of 1,560-1,600°C must be maintained in the ladle.

Bottom-casting in a carbon tetrachloride atmosphere is best applied in filling non-lubricated but thoroughly cleaned ingot moulds.

STEEL PRODUCTION IN CZECHOSLOVAKIA*

A. Danigelka

Ministry of Metal and Mining Industries of the Czechoslovak Republic

The Czechoslovak Republic is one of the countries with a relatively highly developed industry. The steel output there per head of population was 372 kg in 1956. The equipment of our steel works includes 70 open-hearth furnaces, 80 electric furnaces (mainly of a relatively small capacity), and five 15-ton Thomas-Gilchrist converters. The largest units are 250-ton Talbot open-hearth furnaces (tilting type), and an arc furnace of 35 ton capacity.

In 1956 the average output of open-hearth furnaces in 24 hours was 5.18 ton per 1 m^2 of bottom area. This output is still considerably lower than the corresponding figure for Soviet furnaces, the reason being a greater number of low-capacity furnaces, and the less full use of the calendar time (82%). In addition only 45% of furnaces have basic roofs; only 19% of furnaces are fitted with automatic controls. As yet only two works are supplied with oxygen, and this in inadequate quantities.

The output of electric steel represents 12.3% of the total steel production. The percentage of special steels produced is 17.6.

As the ore deposits of Czechoslovakia are inadequate for the production of large quantities of standard grades of steel, it is considered more practicable to concentrate on the production of special grades of steel. It is, therefore, planned to increase their share in the total output to 22%.

Despite some unfavorable conditions, the Czechoslovak steel melters are striving to catch up with the leading countries; new steel-melting shops are being built in steel works, the initiative of great numbers of workers is improving from year to year, and finds its expression in the continuous increase of the productivity of labor and the number of suggestions concerning the rationalization of work.

For example, a suggestion regarding the melting of high alloy stainless steels in open-hearth furnaces was of great importance to us. This method is still used to some extent as it is cheaper and simpler than the conventional method of melting stainless steel scrap, involving the injection of oxygen.

In the past, the use of open-hearth furnaces in melting stainless steel by the scrap process was considered impossible. We studied this problem and found that in certain conditions it was possible. In this new process the sorted and cleaned scrap of a known grade of steel is loaded into the open-hearth furnace without adding pig iron and slag-forming materials (lime, ore, etc.), and melted with the oxidation limited to a possible minimum. This is achieved by keeping the percentage of silicon in the charge high (about 1%). The lining and roof of the open-hearth furnace must be basic. The relatively small furnaces of about 30 ton capacity are considered most suitable for this process.

The melting of stainless steel is facilitated by the fact that there are no non-metallic slag-forming additions in the charge which would have an adverse effect upon the heat transfer. The absence of pig-iron containing carbon and phosphorus enables the re-melting process to be carried out without oxidation. Only a small quantity of self-forming slag is produced in the process. After the charge has melted, and the bath is hot, this slag is deoxidized by adding 8 kg/ton of 75 % ferrosilicon.

It is not possible to remove carbon and phosphorus during the process, hence their content in the charge should not exceed that of the final product. However, an advantage of this method is that the carbon content does not rise during the process as it does during melting in arc furnaces. If there is a danger that the carbon content will rise it is advisable to add mild steel into the charge. After adding ferrosilicon to the charge, steel is poured from the open-hearth furnace into the electric furnace for the final stages of the process. Owing to the low carbon content, low-frequency electric furnaces have proved most suitable for the process.

* Shortened version of a paper presented to the All-Union Conference of Steel Manufacturers.

The process can, of course, also be completed in open-hearth furnaces. In this case the composition of the charge must be calculated according to the analysis of the finished product, and all the alloying elements such as ferrochromium, ferromolybdenum, nickel and others, introduced into the furnace simultaneously. Ferrotitanium is added into the ladle. The following percentages of alloying elements contained in the scrap remain in the finished metal: chromium — 87%, molybdenum — 94.5%, nickel — 96.3%. The production costs of metal made by this method are 15% lower than those of the process involving the use of oxygen; an additional advantage is that the process being described can be run at a lower temperature. During the several years in which the process has been in use we produced thousands of tons of metal.

Some special structural steels have an increased hydrogen content and show a tendency to the formation of flakes. Czechoslovak steel producers have developed and patented a special method for the manufacture of special steels in electric furnaces; it involves the use of so-called oxygen boiling, and enables the hydrogen content in the steel to be considerably reduced. With this method a violent boiling lasting for about 15 min is again caused in the electric furnace after the oxidation stage is completed, and the oxidizing slag tapped off. To produce this boiling, about 0.25% more carbon is added into the charge than is necessary for the particular grade of steel, and oxygen is blown into the furnace until the carbon is reduced to the required percentage. The resulting violent boiling removes hydrogen from the bath. After boiling a deoxidizing slag is allowed to form in the bath, and the process is completed in the usual manner.

Already in the first experiments the use of this method enabled the hydrogen content in steel to be reduced from 5.9 to 3.4 cm^3 in 100 g. In the course of further development a hydrogen content of about 2 cm^3 in 100 g of steel was obtained which is below the limit at which flake formation sets in.

At present a further method of producing metal from the scrap of structural alloy steels is being introduced in the industry. In this method, which also involves oxygen boiling, the whole melting process is carried out in an electric furnace. It is generally known that the re-melting of the scrap of structural steels by the usual method fails to produce satisfactory results because of the great tendency to flake formation, and because of the excessively high percentage of nonmetallic impurities. The application of the oxygen boiling after the melting reduces the hydrogen content, thus decreasing the tendency to flake formation. The high temperature of the process and the considerable depth of boiling also facilitate the elimination of nonmetallic impurities. In addition, this method of melting involves the partial use of alloying elements: chromium to not less than 50%, and tungsten to not less than 55%.

Our next target is to extend the oxygen boiling process to the re-melting of all structural steel scrap. Apart from the utilization of oxidizable alloying elements contained in the scrap, it will help to relieve normal production capacities from the task of re-melting the alloy scrap, thus improving the quality of the output.

ROLLED MATERIAL AND TUBING MANUFACTURE

IMPROVEMENT OF THE TECHNOLOGY OF COOLING OF ROLLED MATERIAL SUSCEPTIBLE TO FLAKE FORMATION

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According to the accepted method at the "Krasny Oktyabr" Works, the blooms of mill 1150 are subjected to slow cooling in sand beds, the blooms being placed in two rows (the thickness of the sand layer approx. 50 mm). Such a technology ensures a gradual fall in the temperature of the metal at a rate of 6-12°C / hour. Numerous measurements have shown that the cooling of metal in sand beds is very slow at temperatures below 400°C (3-5 °C / hour), and therefore very frequently, especially in the summer months, the metal has to be kept in the sand beds for a longer time than given by the instructions, till it cools down to the final required temperature of 250-130°C (depending on the purpose for which the metal is intended). As a result of this the time of cooling is increased, the sand beds are engaged and, in some cases, the rate of metal rolling is lowered.

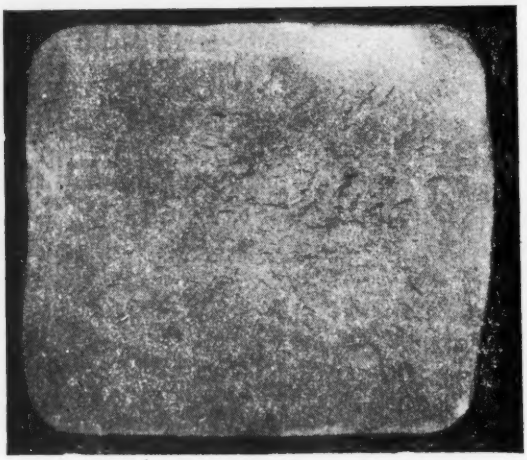
Investigations of the reduced-time method of metal cooling in sand beds were carried out on some 190 by 220 mm blooms from batches of current production of pearlite steel, grades 18-30 Kh GT, 30-35 Kh GSA, 40-45Kh , 37 KhS and others. From each steel batch under investigation one bloom, thoroughly covered with sand and lying in the upper row (blooms placed for cooling in two rows), was taken out of sand after 48-60 hours and exposed to air, while the remainder of the steel batch was subjected to the usual 72-hrs. cooling in sand.

The temperature of the metal after 48-60 hrs. cooling in sand varied within the limits of 250-320°C. Each bloom cooled by method of shortened cooling time and exposed at high temperature to air was subjected to a thorough macroinspection of lateral and longitudinal quenched fractures after two weeks, three and six months aging. No flakes were found in any of the 25 blooms investigated out of 25 steel batches of steels 18KhGT, 40-45Kh and 15MKh. It should be mentioned that all the above named steels were susceptible to flake formation in their original state (after rolling). It follows that 48 hrs. exposure of blooms in sand beds is adequate for the prevention of flake formation.

Such a method of cooling did not always ensure prevention of flake formation in the blooms of high-alloy steels 30KhGT, 30-35KhGSA and 37KhS, characterized by an even higher susceptibility to flake formation. A large amount of flakes was found on the samples of these steels which were air-cooled after rolling (see Figure below).

It was established, on the basis of the analysis of 48-hr. cooling of blooms of steels 30KhGT, 30-35KhGSA and 37KhS which showed flakes, that the mean rate of bloom cooling was 10°C or more per hour. No flake formation was observed at lower rates of cooling. Hence it could be assumed that satisfactory results in the prevention of flake formation in blooms of high-alloy pearlite steel would be attained either by increasing the duration or by decreasing the rate of bloom cooling at high temperature. These assumptions were confirmed by subsequent experiments. It was established that after 60 hrs cooling of blooms of steels 30 KhGT and 37 KhS, in sand beds, the metal had no flakes.

Reduction in the rate of cooling of metal in a sand bed can be achieved either by increasing the sand layer thickness (which is difficult to do under the conditions in the plant) or by increasing the charge by means of placing the blooms in 3 rows. Temperature measurements have shown that on placing the blooms in three rows in sand beds the rate of cooling in the region of high temperatures (700-400°C) decreased markedly as compared with two-row placing. It was established experimentally that on cooling of steel 30KhGT blooms in a three-row charge, in 48 hrs the metal was free from flakes (see Table).



Flakes in a bloom of 30 KhGT steel, air-cooled after rolling.

Results of the Inspection for Flakes in Blooms 190 x 220 of Steel 30 KhGT (three-row placing for cooling)

Placing of the test bloom, row	Duration of cooling, hrs.	Temperature of the bloom on removal from sand, °C	Mean rate of cooling, °C/hr.	Check for flakes after 1-3 months aging
Upper	48	415	7.1	no flakes were found
Lower	98	480	3.3	"
Upper	48	350	7.3	"
Lower	72	360	4.6	"

An investigation of a reduced-time method of cooling of round billets 120-250 mm dia from mill 750 was also carried out. The inspection of this metal revealed that the cooling of section steel in sand beds during the course of 48 hrs (instead of 60-72, according to the accepted method) and in unfired furnaces during 56-64 hrs (instead of 84-96 hrs) eliminates flake formation in the metal.

On the basis of the investigations a new scheme of cooling, in sand beds or furnaces, of blooms and section steel of pearlite type, rolled on mills 1150 and 750, was developed. It is specified in the scheme that after 48 hrs cooling of blooms of steels 18 KhGT, 40-45 Kh and others, in sand beds on two-row placing, the metal temperature should not be below 220°C. For blooms of steels 30 KhGT, 30-35 KhG SA and 37 KhS, with three-row placing the metal temperature should not be below 250°C. Subsequent cooling of blooms may be carried out in air without the danger of flake formation.

The new 48-hr scheme of bloom cooling made it possible to increase the out-put of the slow-cooling sections of the rolling plant in the "Krasny Oktyabr" Works.

A SCHEME OF SPEEDED-UP DELIVERY OF HOT METAL TO THE PIT FURNACES OF THE BLOOMING MILL

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The high operating efficiency of the blooming mill and the ensuring of the supply of the required semi-finished rolled product to other mills according to a planned scheme can be attained only under the condition that the required amount of hot metal from open-hearth plant No. 1 is delivered to the pit furnaces of the blooming mill.

The Production and Work Organization Laboratory in collaboration with the Mold Preparation Plant have carried out a complete study of the whole process of treatment and transport of molds with metal from the end of metal teeming till the delivery of molds to the pit furnaces, including the stripping of ingots. New norms were established and a new improved organization of production was established in the section, and the adoption of the new scheme began in October, 1956.

The new, speeded-up scheme provides for increasing the temperature of furnace charging by approx. 50-70°C. on account of reducing the time of hot metal delivery to the blooming mill pit furnaces, in min:

	Ladle	
	first	second
Killed metal	25	35
Rimmed metal	10	15

The determined duration of individual operations according to the speeded-up scheme and their sequence are shown on the diagram.

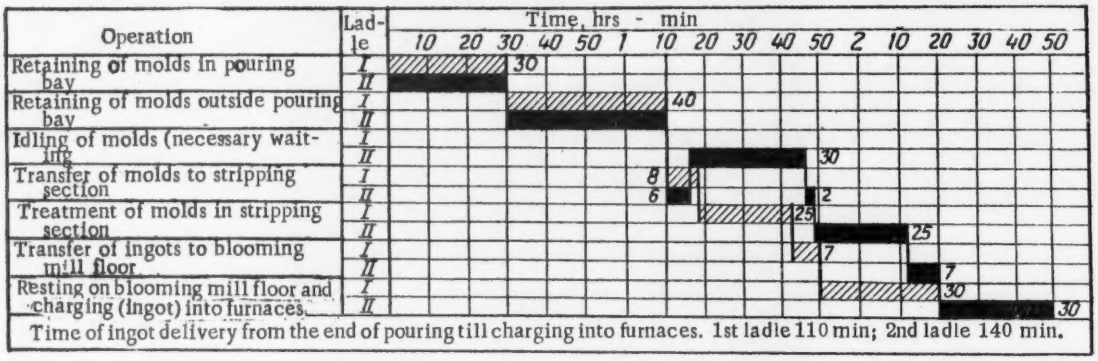
A regulated system of operation of the pouring section, stripping section and blooming mill furnaces was also developed and it provides for the following:

1. Reduction by 5 min in the time of retaining of the filled molds with killed steel in the casting bay and the advancing of ingot stripping by 7 min. Experience showed that the reduction of residence time of ingots in the mold had no effect on the quality of the metal.

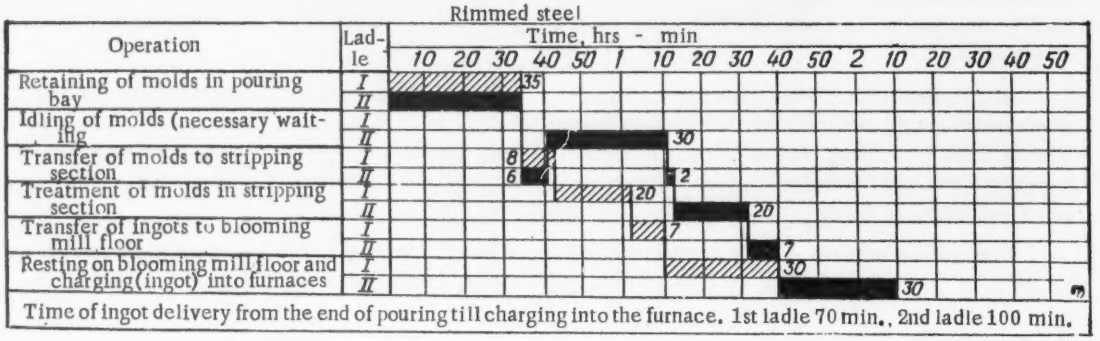
2. The use of two cranes simultaneously for each mold set in the stripper; the first crane lifting 1st-4th molds and the second 5th-8th molds of each set. Such a procedure makes possible a reduction in the time of rimming-steel ingot treatment in the stripper by 5 min and of killed steel ingot by 10 min. In addition, on the delivery of ingots of the steel batches from a 370-t open-hearth furnace, poured into two mold sets, in order to maintain the temperature of the metal the treatment of the second set is carried out with a 30-min interval. This time is necessary for charging the ingots from the first set into the soaking furnaces. Such a procedure in the delivery of mold sets for stripping is envisaged for all remaining cases.

3. As a rule, only one set of ingots at a time should be treated in the soaking pits. The transfer of the ingots from the set is done by two cranes, provision being made for the splitting of the set and the charging of the ingots from one set into different groups of soaking pits. With such an organization of operations the time of ingot charging and the residence time of the set in, including the time of its removal from, the soaking pits floor should constitute 30 min.

Killed steel


Operation
Ladle
Time, hrs - min
10 20 30 40 50 1 10 20 30 40 50 2 10 20 30 40 50
Retaining of molds in pouring bay
Retaining of molds outside pouring bay
Idling of molds (necessary waiting)
Transfer of molds to stripping section
Treatment of molds in stripping section
Transfer of ingots to blooming mill floor
Resting on blooming mill floor and charging (ingot) into furnaces
I
II
30
40
30
8
6
2
25
25
7
7
30
30
Time of ingot delivery from the end of pouring till charging into furnaces. 1st ladle 110 min; 2nd ladle 140 min.

Rimmed steel


Operation
Ladle
Time, hrs - min
10 20 30 40 50 1 10 20 30 40 50 2 10 20 30 40 50
Retaining of molds in pouring bay
Idling of molds (necessary waiting)
Transfer of molds to stripping section
Treatment of molds in stripping section
Transfer of ingots to blooming mill floor
Resting on blooming mill floor and charging (ingot) into furnaces
I
II
35
30
8
6
2
20
20
7
7
30
30
Time of ingot delivery from the end of pouring till charging into the furnace. 1st ladle 70 min., 2nd ladle 100 min.

Scheme of mold and ingot treatment from the end of pouring till the placing of ingots in the soaking pits.

4. The dispatcher of the mold sets preparation plant, on receiving the report of the completion of pouring, makes the scheme for further treatment and delivery of the filled mold assemblies to the blooming mill furnaces, allotting minimum time for individual operations. This scheme is coordinated with the dispatcher of the blooming mill.

The adherence to the speeded-up scheme ensures the delivery of metal to the soaking furnaces of the blooming mill at the mean temperature of 850°C. or above, which, in turn, increases the through-put capacity of the soaking furnaces and creates conditions for a high operating efficiency of the blooming mill.

The delivery of each ladle in accordance with the scheme ensures the following temperatures of metal, °C:

	Ladle	
	first	second
Killed steel	960	900
Rimmed steel	870	805

Simultaneously with the adoption of the speeded-up scheme of the hot metal delivery, revision was made of the remuneration of the stripping section workers and of the railroad section teams employed on the transport of hot metal. The existing payment system was based on the payment according to double evaluation for the ingot sets delivered according to the scheme (from the end of pouring until delivery to the blooming mill furnaces) and did not provide any incentive for speeding-up of the ingot sets thus resulting in a fall of the temperature of the metal.

In order to cause workers to take interest in securing a maximum temperature of ingots, instead of the above system a progressive extra payment for ingot sets charged into the blooming mill furnaces at a minimum interval between two consecutive deliveries was established.

The extra payment for each ingot set is:

Time interval between the deliveries, min:	up to 30	31-40	41-60	above 60
Extra pay (coefficient for the basic evaluation)	2.0	1.5	1	–

Improvement in the Delivery and Treatment of the Hot Ingot Sets

Month	Time for the transfer of sets from the open-hearth furnace plant to the blooming mill, hrs – min.				Temperature of metal at charging into soaking furnaces			
	killed steels		rimmed steels		killed steels		rimmed steels	
	Ladles							
	I	II	I	II	I	II	I	II
September	2-52	3-12	2-14	2-55	840	800	750	675
October	2-19	2-48	1-48	2-25	900	840	785	730
November	2-06	2-37	1-42	2-12	930	860	805	750
December	2-10	2-41	1-48	2-19	920	860	785	740

The table shows the results of the adoption of the speeded-up scheme and of the introduction of the new payment system beginning in October, 1956.

The improvement in the regular delivery of the metal to the blooming mill furnaces and the increase in the temperature of the delivered ingots as well as other organization and technical steps were conducive to an increased output of the blooming mill:

	September	October	November	December
Mean daily output, %	100.0	102.5	111.1	110.4
Mean hourly output, %	100.0	101.2	106.8	107.2

With a view to a further increase in the temperature of ingots delivered from the open-hearth furnace plant No. 1 to the soaking furnaces of the blooming mill, it is intended to change over to 7-t killed steel ingot from 6.2 t ingot and to install bracket cranes in the pouring bay of open-hearth plant No. 1 for the mechanizing and speeding-up of the covering and removal of the covers on teeming of rimming steel.

THE REDUCTION OF OPERATIONAL COSTS IN THE PLANT

P. P. Zuev

Head of Rolling Plant No. 1 of the "Elektrostal" Works

In the rolling plant of the "Elektrostal" works the operational costs per ton of rolled product are distributed as follows,%:

Operational fuel	12.9
Power consumption	9.7
Wear of exchangeable equipment	8.8
Remuneration to repair and maintenance shops	2.2
Expenditures on grinding discs	5.9
Depreciation of basic machinery	2.9
Transport of material	0.9
Remuneration of the personnel of the Technical Control Department	2.2
Wages and deductions	51.5
Other plant expenditures	3.0

For economy, the walls of the reheating furnaces are covered on the outer side with an insulating brick joined to the main brickwork; the thermal insulation of the furnace roofs has been replaced: instead of fettling the roofs with fire brick powder and boiler slag, the roofs are now lined with porous fire brick and the joints are filled with quartz powder over the silica-brick part of the roof, and with fire-brick powder over the fire-brick part.

A record is kept, from the beginning of each month, of fuel oil consumption per shift and per 1 ton of rolled product for each operational team and for the plant as a whole. At the end of a month a recalculation of fuel oil consumption is made taking into account its moisture content.

In 1955, the plant saved 72 t of fuel oil representing 20,000 rubles saving.

The most substantial item in power cost is the electric power consumption. In order to lower electric power consumption it is necessary to reduce idling periods, to observe strictly the technical rules of operation, to improve the standard of the scheduled preventive mill overhauls. The choice and installation of electric motors of the appropriate power is also of considerable importance in the economy of electric power consumption.

The plant has introduced the recording and analysis of electric power consumption for each shift and for each mill team; thus one is in a position to determine the time and the reasons of overconsumption or saving in electric power and to disclose any unutilized potentialities.

The electric power consumption per 1 t of rolled circular section steel product constitutes from 75 (for circular bars of 24 – 40 mm dia) to 205 kw-hrs (for circular bars 8 – 9 mm dia).

The lubrication of all roll necks before starting the mill and the loosening of pressure bolts made it possible to effect the following reductions in the power consumption per pass: on mill 300 from 50 – 60 to 40 – 45 kw-hrs, on mill 450 from 30 – 35 to 20 – 25 and on mill 600 from 40 – 45 to 30 – 35 kw-hrs.

On mill idling up to 10 min, the speed should be reduced without stopping the mill, as more power is required for starting the mill than for idle running for 10 min.

In recent times electric motors have been replaced in several sections of the plant, the power capacity being reduced by 40.8 kw-hrs.

Owing to the above measures a saving of 82,000 kw-hrs. of electric power (12,300 rubles) was effected in one year.

The reduction of expenditure on the services of repair shops, on wear of exchangeable equipment and spare parts, and on auxiliary materials and apparatus, is attained by observing the rules of equipment operation, by improving the quality of scheduled preventive overhauls, by perfecting individual units of machinery and by replacing expensive materials with cheaper ones. The following measures were taken in the plant.

The diameter of the rolls of the driving stand of mill 600 were increased so that now the distances between the centres of the driving and working rolls is equal (previously they were 575 and 610 mm respectively). This change resulted in the reduction of coupling consumption by 150% and of driving rolls by 200%.

The rolls of mill 600 are made of steel 40 KhN instead of 50 KhN and this has increased their life. Also some parts of the swing saw have been strengthened, a roller bearing housing has been adopted and parts of the overhead crane joints have been strengthened.

The consumption of grinding discs for polishing of 1 ton of metal constitute from 2.5 for carbon tool steel to 6-7 for alloy steel. For the removal of local defects 0.3 - 0.6 of grinding disc is consumed per 1 ton of steel.

On a prolonged storing of grinding discs (more than 6 months) their consumption increases by 35- 70%.

On the basis of long time observation of grinding discs consumption, it was established which discs, according to hardness and grain size, are most suitable for use in the treatment of steels of different makes:

Steel under treatment	R9–R18; 2Kh13–4Kh13	Carbon tool steel	Nichrome steel and alloys
Grinding discs:			
grade	ST_1– ST_2	ST_3–T	ST_2– ST_1
grain number	12–16	16–24	12–16

The adoption of these measures resulted in an annual saving of 72 500 rubles. We recommend the following rules regarding the choice of grinding discs according to grain and hardness:

1. For the increase of operating efficiency it is necessary to use a fairly soft disc with large grain; a soft disc is self-sharpened more easily. The blunted grain crumbles off quicker hence the grinding is done by sharper grains; too soft a disc is not recommended because then the consumption of discs increases rapidly without a corresponding increase of operating efficiency;

2. For the grinding of plane surfaces of square billets a softer disc should be used than for the grinding of round billets;

3. In order to obtain a bright surface, without scarring, it is necessary to use a softer disc.

4. Prolonged storing reduces the durability of discs to a considerable degree.

The expenditure on wages with deductions constitutes half of all the operational costs in our plant. The high proportional amount of wages is caused by a large number of workers employed at the mills and on metal finishing (53.4 and 33.4 % respectively) and this is connected with the use of stands of old construction, manually operated for all the main operations. In addition, a large number of grinders is required for the finishing of alloy steel product.

It follows that in order to reduce labor cost, the mechanization of the processes and the improvement in the quality of the metal surfaces are required.

The Gipromez designers are still in debt to the mill operators as they have not yet designed mechanical appliances for metal surface polishing. Thus the output of a grinder per shift on polishing round bars 85 mm diameter and 1 m long does not exceed 1 ton,and on polishing square billet 122 mm side and 1.5 m long, exceeds 1 ton only in a few cases.

Reduction of the production cost can be attained byutilizing production wastes available e.g., in the case of metal nickel dust (grinding), from metal working on grinding machines; in the form of tungsten-containing scale; and in iron scrap.

Up to 1951, the grind dust was disposed from the plant and dumped; now plant workers, during the day-off of the grinding section, collect the dust from the grinding tables, screen it and put it into special containers.

The value of 1 ton of nickel dust depends on the nickel content. The dust, containing up to 10% nickel, is sold at 6,500 rubles / ton and at 8,500 rubles / ton when containing more than 10% nickel.

Tungsten-containing scale is stored separately and is sold at 450 rubles p. ton. A ton of other scale costs 36 rubles. In addition, all steel and iron scrap of the plant is collected every month and delivered to the metal center.

With a view to a further reduction in operational cost it is necessary, in cooperation with engineering and technological workers and mill foremen, toanalyze the results of the consumption of power, fuel and materials, and to develop and practically apply the measures intended for a further decrease in operational cost.

TUBEWELDING BELL WITH DETACHABLE RINGS

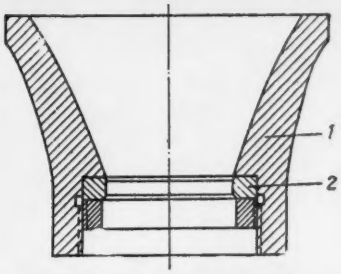
Engineer T. K. Romershtein

Lenin Tube Works

In 1952 and 1954, inter-works schools of advanced experience in butt welded tube manufacture on stationary mills were conducted on the works of ferrous metallurgy. The participants - engineers, technologists and outstanding tube welders - studied the technique and production organization, noted the achievements of each plant and then recommended measures for the increase of operating efficiency, improvement of tube quality, reduction of expenditure coefficients and improvement of the working conditions of operators.

In our plant, for instance, on the recommendation of the school, the thermal insulation of the roofs and walls of the welding furnaces was improved (from the Vyksunsk Works experience); from the experience of the Andreev Works the gripping arrangement on the draw chains was improved, thus increasing the safety of the tube welders' work; from the practice of the Leningrad Works roll tables for the return of tongs from groovers to welders were installed, thus facilitating the work of 35 men. The introduction of these and several other measures has improved the work of our plant. In 1956, 192 t of conventional fuel and 107,000 kw-hrs were saved; the saving on the reduction of production cost, below the planned reduction, constituted about 200,000 rubles. The output target for 1956 was exceeded (102.2%) of planned output) and in the first quarter of 1957 105.3% of planned output was achieved.

The participants of the school have recommended other plants to utilize the experience of our works as regards maintenance of the thermal conditions of the furnace, the sequence of operations of the production process (the sequence of the skelp removal from the furnace and the charging of the next skelp into the furnace) and others.



Welding bell made of nonmodified cast iron with detachable ring made of high speed steel. 1) Bell; 2) ring.

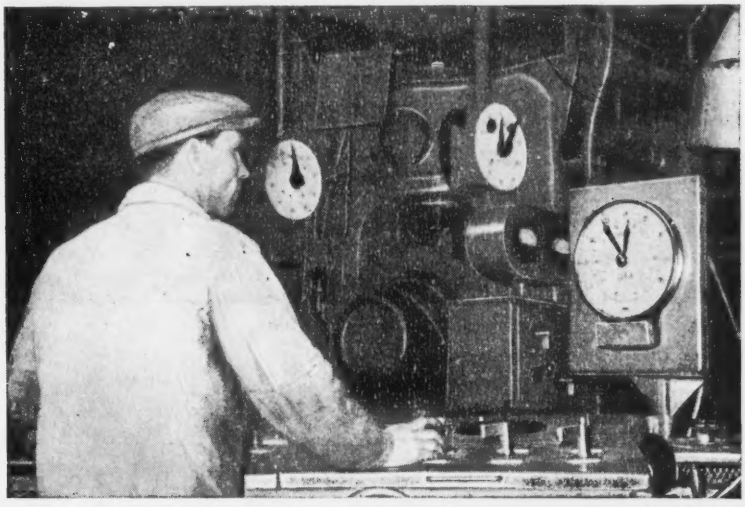
Under the conditions of furnace welding the furnace for skelp heating determines the output capacity of all the equipment. Of great importance is the welding bell in which skelp is welded into tubing. Up to the present, tube mills are using bells made of grey cast iron, containing 3.4-3.6% C and 1.3-1.6% Si and modified with 75% ferrosilicon. The bell is cast into a metallic chill mold and normalized at 950°C. Such a method was recommended on the basis of the experience in the Yakubovsky Works in Voroshilovgrad in the Vyksunsk Metallurgical Works. However, the durability of the bell no longer conforms with the present day thermal conditions in the furnace and with the intensified heating-up of the skelp – so that the "burning" of bells has a detrimental effect on the quality of tubing and the welders frequently have to lower the furnace temperature.

On the suggestion of a group of workers in our works, the plant has adopted, beginning in September, 1956, a new method of welding bell manufacture from nonmodified cast iron with detachable rings made of high-speed steel R18 (figure).

The rings of forged steel R18 are oil-quenched at 1270°C and tempered three times at 560°C. The rings are welded to the body of the bell or fixed by a nut.

At the end of the welding part of the bell, a thread for the nut is cut and to prevent unscrewing the nut is welded to the bell body in two opposite places. The ring is replaced when required and the nut is used until completely worn out.

According to the data of the TsZL (Central Works Laboratory) the durability of new bells is ten times higher than the old ones made of modified cast iron. The hourly tube output has increased by 7-8% owing to the adoption of detachable rings.



Atomic energy has an ever increasing application in the "Zaporozhstal" Works. It is utilized in several technological processes. By means of isotope apparatus a continuous, contactless measurement of hot plate thickness is made – a contactless, continuous measurement of the plate thickness in the process of rolling is made by means of labelled atoms. Such equipment is operating on the continuous cold rolling mills and tin plate plants. The photograph shows an isotope micrometer equipment in the tin plate plant.

TIN SAVINGS IN TIN PLATE PRODUCTION

NEW METHODS FOR PROCESSING TIN-CONTAINING WASTES

The cost of tin consumed in the production of hot dipped tin plate constitutes about 50% of tin plate cost. Therefore an economical use of tin is an important task in the national economy.

In the process of plating, only 75-80% tin is used for covering the sheet and 15-20% of tin forms various tin-containing wastes. Therefore, the adoption of effective methods of reprocessing of tin-containing waste of the tin plating industry is of considerable importance.

The main forms of tin-containing waste are flux and oil scruffs, light and heavy metals (crystals of tin-iron alloy, $FeSn_2$, embedded in reguli of pure metallic tin). These wastes are unavoidable in hot-dip plating. They vary in amount at different works within the limits of 3-7 kg per ton of useful tinplate.

In recent times, the Seversk Metallurgical Works and the Novomoskva Tin and Plate Works have tested new methods of tin-containing waste processing. The two methods of processing are of great interest as they ensure a complete recovery of tin which is used again in the hot-dip bath.

I

M. S. Arkhipova and V. D. Mishin (Ural Polytechnic Institute)

N. S. Smirnov (Seversk Metallurgical Works)

The exploration and the development of an effective processing method of tin-containing wastes were carried out in the laboratory of the Department of nonferrous metals of the Ural Polytechnic Institute and on semi-industrial equipment erected at the Seversk Metallurgical Works.

The developed scheme of hydro-metallurgical processing of flux scruff makes possible a more rational utilization of the valuable constituents of this main waste of hot-dipped tin plating.

After the separation of metallic tin and heavy metal in the kettle, the molten secondary flux scruff, containing 33-36% of zinc and 12-13% of tin, is poured in a continuous thin stream into a water-filled vessel. A granulation takes place with a fast dissolution of zinc chloride. Filtered and washed precipitate, containing mainly tin oxychloride, is transferred to another vessel and 10% hydrochloric acid is added. Nearly all the tin goes into the solution.

For a complete extraction of the tin which does not dissolve in the 10% hydrochloric acid, the remaining precipitate may be treated with concentrated hydrochloric acid and heated, the solution obtained being then added to the main solution. The hydrochloric acid solution is then transferred into a container for the separation of sponge tin on aluminum plates. The separation of sponge tin is a most complex operation during which the following conditions must be maintained.

1. The total surface area of the aluminum plate should be adequate for ensuring a high operating efficiency of the equipment. Thus, with the decrease in the quantity of tin precipitating on 1 cm^2 of the plates from 0.54 to 0.22 gm, the yield of metal increased from 39.32 to 94.72% (in the same time). It should be noted, however, that on high intensification of the process the quality of the sponge deteriorates.

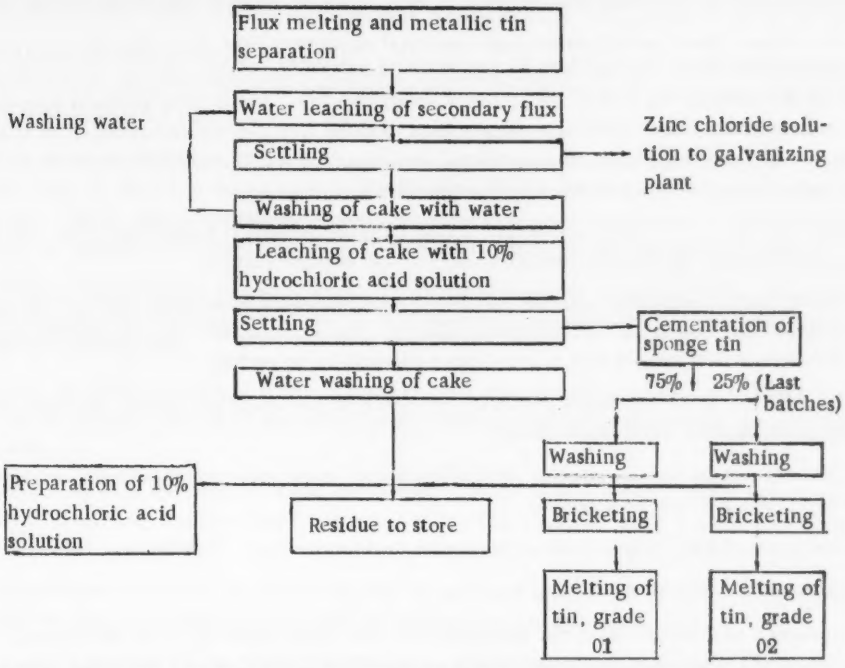


Fig. 1. Flow-sheet of flux scruff reprocessing in the Seversk Metallurgical Works.

2. The process of sponge precipitation must be conducted in stages: first sponge removals give perfectly pure tin corresponding to the grade 01 (GOST 860-47). Tin in the subsequent batches contains considerable lead impurities. The experiments on the behavior of lead in a step-by-step removal of tin sponge have shown that with the decrease of tin concentration in the solution, the lead content in the tin sponge rapidly increases. On removal of tin sponge every 30 minutes, the yield of metal and its lead content were as follows (at tin concentration 121.7 gm/liter and hydrochloric acid 25 gm/liter), in %:

Metal yield:	39.32	16.35	18.09	14.66	3.65
Lead content in metal:	0.044	0.021	0.055	0.026	0.22

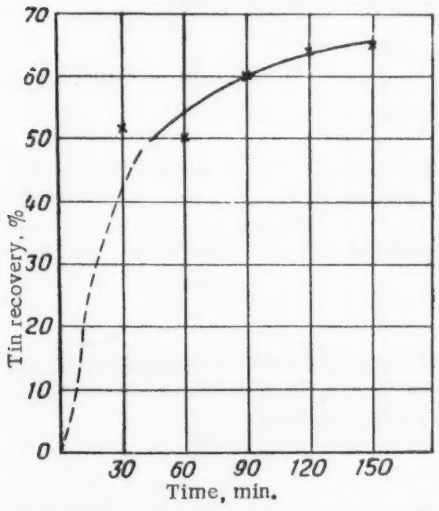


Fig. 2. Dependence of metallic tin recovery on the time of cementation.

3. The acidity of the solution used for tin precipitation must be kept constant at about 20 gm/liter. The increase in acidity favors the acceleration of the cementation process of tin, but at the same time increases the aluminum consumption per unit weight of tin recovered.

4. The temperature of the solution should be maintained within the limits of 20-50°C, as any further temperature increase favors the increase in aluminum solubility and the decrease of tin yield on the remelting of tin brickets.

The tin sponge removed from the aluminum plate is delivered in vessels with water (to prevent oxidation) for bricketing, which is done on pressing machines. The tin sponge brickets are also stored in water and then they are melted into tin ingots in a kettle at 245-250°C under a layer of cottonseed oil (or melted zinc chloride).

5. The intervals between successive sponge removals should not exceed 30-60 minutes because the process of

separation becomes slower with time and the yield of metal does not increase significantly (Fig. 2).

Material-balance tests carried out on semi-industrial equipment have shown that the recovery of tin from the secondary flux scruff reaches 86.5%. When tin obtained in the initial settling of flux scruff in a molten state in the kettle is included, the recovery constitutes 91%. In the semi-products supplied to works for the reprocessing of secondary nonferrous metals, there remains 7.7% tin; the remaining 1.3% constitute loss. 72.1% of the total tin quantity recovered in industrial tests was of grade 01 and 22.9% of grade 02. Aluminum consumption does not exceed 0.2 tons per ton of produced tin.

On dissolving molten secondary flux scruff, a zinc chloride solution is formed in water. The dissolution process is maintained until the specific weight of the solution reaches 1.5-1.6.

The recovery of zinc chloride from the flux scruff for reprocessing constitutes 80.2%. This valuable product was irretrievably lost in the old processing scheme. This solution, after the precipitation of sulfates by calcium chloride, is now used as flux in hot-dipped galvanizing of roofing.

Industrial equipment for flux scruff processing according to the described scheme has been in operation at the Seversk Metallurgical Works since 1954.*

The following regime for an optimum yield of tin sponge under industrial conditions, established in the course of process operation, can be assumed:

a) temperature of hydrochloric acid solution prior to tin separation: 20-25°C;

b) tin content in solution: 65-75 gm/liter;

c) temperature of solution during the tin separation: not above 50-60°C. With the increase of solution temperature above 60°C there is a possibility of tin sponge oxidation which would result in a lower yield of metallic tin.

The following modifications were introduced into the processing of heavy metal and oil scruff, on the basis of a laboratory study.

After the melting out of tin from heavy metal and oil scruff, the scale obtained is ground in a ball mill and screened on a vibrating screen into a malleable and a powder fraction.

The malleable fraction is remelted in a recuperative furnace under a layer of charcoal at 400-450°C for the first two hours, and at 650-700° during the four subsequent hours. As a result, an additional 7-8% of tin is recovered. The powdered fraction is sent to the Vtortsvetmet (Secondary Non-Ferrous Metallurgy) plants.

The economic indices of tin-containing wastes of the tinning industry by the old and the new methods are as follows (tin recovery and ash yield are determined relative to the quantity of process wastes):

Method	Old	New
Tin recovery, %	12.6	26.8
Ash (scale) yield, %	26.6	22.1

II

R. Koftan, Head of the Central Works Laboratory of the Novomoskva Tin Plate Works

In recent years the amount of tin-containing wastes in our plant and their tin content have reached a very low level owing to better preparation of iron sheet prior to tin plating, a lowering of flux acidity and the change in the method of removing the wastes from the automatic tin plating machines.

* T. B. Bokareva, engineer-research worker of the TsZL (Central Works Laboratory) took part in the adoption of the proposed method.

The flux scruff, when removed during the change, is transferred from the scruff space onto a pool of liquid tin in a special container, where it is treated with soda (approximately 100 gm per 15-20 kg of scruff).

Light metal (oil scruff) collecting under the lower pair of oil machine rolls is transferred, during the roll changing, into the flux space by means of a perforated ladle. The mixture of light metal and used flux on the molten tin pool is also mixed with 2-3 kg of soda.

The soda treatment helps to remove the reguli of pure tin from the flux and oil scruffs. Thus at the present time the final waste of the tin plating process is the mixture of light metal and flux scruff treated with a small quantity of soda. These wastes, containing a minimum amount of tin (approximately 10% of its total consumption in tin plating), are transferred to the recovery process of tin of grade 01, suitable for tin plating.

The wastes are not uniform in composition and consist of metallic tin reguli, $FeSn_2$ alloy, tin chlorides, iron, lead and copper. All these are cemented by used flux (zinc chloride) into a solid mass containing 50-60% tin (evaluated as metallic tin).

Until now, the plants producing tin plate processed the tin-containing wastes by an inefficient roasting method and recovered only 50-60% of the refined grade 01 tin contained in the wastes, the remaining 40-50% of tin being lost.

Simultaneously with the work aimed at the reduction of tin consumption, a hydro-chemical method of tin-containing waste processing was developed and tested on a semi-industrial scale in 1954-1956 (full-scale industrial equipment is being designed).

The hydrochemical method almost doubles the tin recovery coefficient by eliminating the irretrievable losses and allowing only for a minimum quantity of final tin-containing waste.

The wastes, after their removal from tin plating machines, are charged into acid resisting tanks and are dissolved in a hydrochloric acid solution at 75-80°C. The above mentioned constituents of wastes pass into a solution in the form of chlorine compounds of tin, zinc, iron, copper etc.

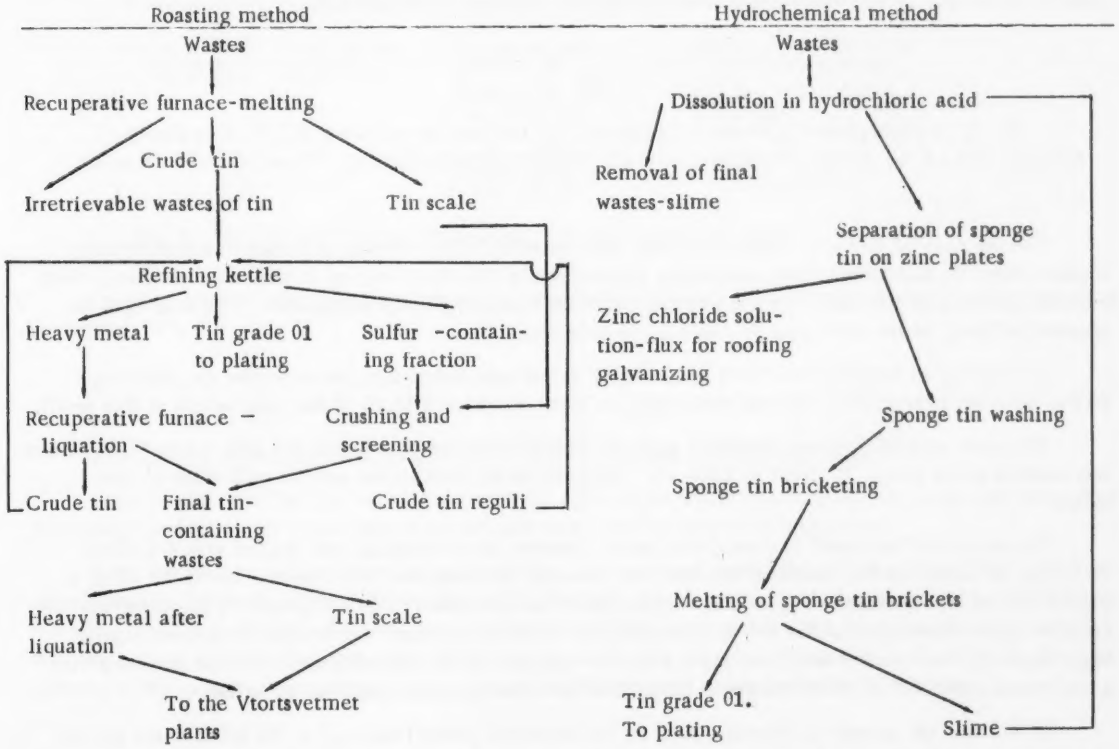


Fig. 3. Comparison of flow-sheets of tin-containing waste processing to the Novomoskva Tinplate Works.

Comparison of Results of Processing of Tin-Containing Wastes by Firing and Hydrochemical Methods (tin content in wastes = 100%)

Results of waste processing	Method	
	Roasting	Hydrochemical
	Yield, %	
Recovery of tin, grade 01	55-60	90-95
Formation of final tin-containing wastes	25-30	5-10
Irrecoverable tin losses	10-15	None

Zinc plates, 500 x 200 x 20 mm, are immersed in the solution and the tin from the chlorine compounds separates out in the form of sponge tin on the zinc plate surface and the plates dissolve, thus enriching the solution with zinc chloride salt. The sponge tin is removed from the solution and the zinc and iron chlorides are washed off with water. In order to recover the particles of sponge tin from the wash water, the water is passed through trap-tanks before going to drain.

The washed sponge tin is bricketed in steel dies on 400-ton pressing machines. Pressed sponge tin brickets of 5.5-6 specific weight, 90-100 mm diameter and 120-140 mm long are obtained. The brickets are melted in fused metallic tin in a kettle. In order to prevent oxidation they are immersed in the melt and kept immersed by a special net. After melting, tin of grade 01 is obtained, requiring no special refining.

In the tank where sponge tin is separated, a solution of zinc chloride which constitutes a flux suitable for use in the galvanized roofing production, is formed.

The main advantages of the hydrochemical method are the simplicity of equipment and technology of the process and the absence of roasting operations causing tin oxidation and irretrievable waste (see flow-sheet, Fig. 3).

The adoption of the hydrochemical method of tin-containing waste processing on our plant will make it possible to recover an additional 3-4% of tin (of its total consumption in plating).

III

G. I. Kanonykhin (Head of Chemical Laboratory) and V. S. Lysakov, Deputy Head of OTK (Department of Technical Control), "Amurstal" Works

The recovery of tin in our Works for a long time consisted of the melting of wastes in a reverberatory furnace where tin and scale (ashes), containing approximately 30% tin in form of oxides, were obtained. Such valuable products as zinc chlorides and stannous chlorides were completely volatilized. The recovered tin required refining, where additional tin losses again occurred.

On melting an experimental batch of flux scruff it was established that the recovered tin, requiring further refining, constituted 14.3% and scale – 27.3%; losses constituted 58.4% of the total weight of flux scruff.

The same method of waste processing as at the Seversk Metallurgical Works, but with a simplified scheme, was adopted in our plant. It allows an adequate recovery of tin from wastes and the utilization of zinc oxide.

The collected flux scruff in a semi-fluid state is poured into a container and diluted with 4-5 times its weight of water. As the wastes accumulate, the container is transferred into a special room, the scruff is poured into an acid-resistant tank, technical hydrochloric acid is added (150-200 gm per kg of wastes) and the contents mixed thoroughly. After 2-3 hours settling, the solution separates into two sharply divided layers: upper layer of clear solution and lower layer with tin reguli and slime. Floating impurities are removed with a perforated ladle and the clear solution is transferred into another similar tank placed below.

In this tank the sponge tin is precipitated on the aluminum plates immersed in the solution and placed at a distance of 120-150 mm from each other. The dimensions of the plates depend on the size of the tank

(the thickness is arbitrary). The tin separates very quickly. In order to prevent a substantial dissolution of aluminum, it is necessary to check the extent of precipitation by means of an aluminum control plate; if there is no precipitation of tin on it, the plate should be immediately removed from the solution.

The solution is passed though a cloth filter into the third tank for the separation of zinc, and the sponge tin is thoroughly washed with water until the zinc ions are removed. The moisture is then removed, and the tin pressed into brickets and melted. The melted sponge tin corresponds to grade 01 according to GOST 860-41 and does not require refining.

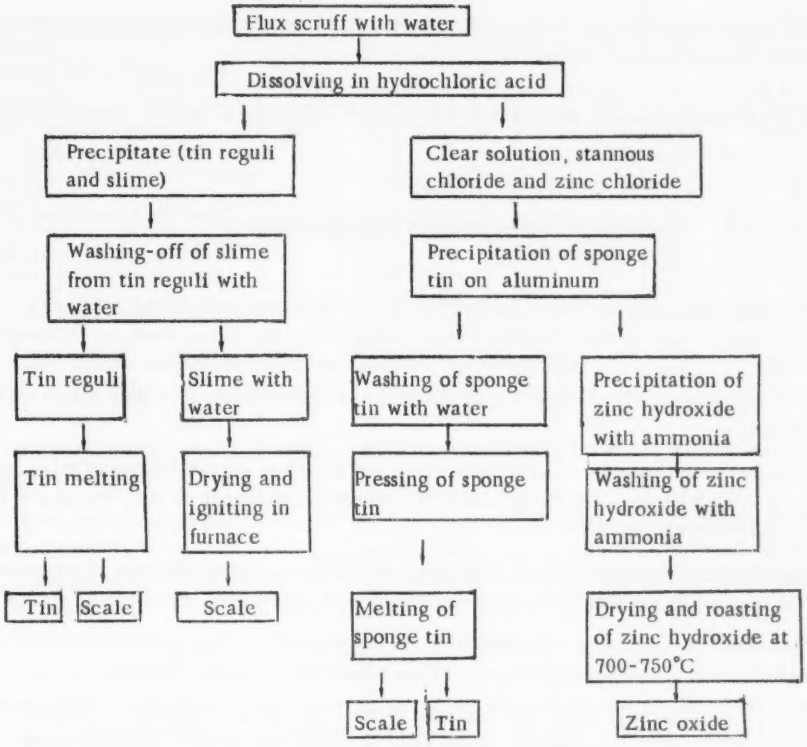

Flux scruff with water
Dissolving in hydrochloric acid
Precipitate (tin reguli and slime)
Clear solution, stannous chloride and zinc chloride
Washing-off of slime from tin reguli with water
Precipitation of sponge tin on aluminum
Tin reguli
Slime with water
Washing of sponge tin with water
Precipitation of zinc hydroxide with ammonia
Tin melting
Drying and igniting in furnace
Pressing of sponge tin
Washing of zinc hydroxide with ammonia
Tin
Scale
Scale
Melting of sponge tin
Drying and roasting of zinc hydroxide at 700-750°C
Scale
Tin
Zinc oxide

Fig. 4. Flow sheet of flux scruff processing at the "Amurstal" Works.

On processing an experimental batch under laboratory conditions, the tin obtained contained the following impurities, in %:

Pb	Fe	Zn	Al
0.013	0.003	0.001	0.001

Aluminum consumption constitutes 1/6 by weight of the precipitated and melted tin.

Liquid slime from the first tank is separated from the metal reguli by siphoning into a separate tank. The remaining residue of reguli and slime is mixed with water and the siphoning is repeated.

After the removal of the main bulk of the slime, the reguli are again washed a few times with water and then melted in a furnace. Depending on the purity, the tin is passed to the tin plating machines or subjected to refining. The slime is left in the tank until settling is complete, after which the upper liquid layer is drained. The thick slime mass is dried and ignited in a furnace. The scale obtained is combined with the scale from the melting of the sponge tin and reguli, and is sent to the Vtortsvetmet plants for further processing.

Zinc hydroxide is precipitated from the solution poured into the third tank after the sponge tin precipitation, with ammonia which is added in small portions with constant mixing until the complete precipitation of zinc hydroxide. In the presence of excess ammonia, zinc hydroxide may redissolve; therefore, the ammonia should be added only until a faint smell persists.

White zinc hydroxide precipitate is water washed in cloth filters until it is chlorine ion free and then it is dried and roasted in an electric furnace at 700-750°C. The white zinc oxide produced can be used for white paint (white zinc pigments) or for other industrial purposes. 400 gm of a sufficiently pure zinc oxide can be obtained per kg of flux scruff.

The equipment for the chemical processing of flux wastes should be placed in an isolated room provided with an intake and exhaust ventilation system.

ADVANCED EXPERIENCE IN MEDIUM SECTION ROLLING MILL OPERATION

I. N. Fillippov

Ukrainian Scientific Research Institute of Metals

In 1956, at five Southern works an inter-works school of section mill operators was organized. The school studied the work of mill 500 of the Dzerzhinsk Works, mill 500 of the Kirov Works in Makeevka, mill 585 of the Frunze Works, mill 550 of the Petrovsk Works and mill 550 of the Enakievka Works.

Welders, rolling operators, heads of shifts, senior foremen and deputy heads of rolling plants took part in the work of the school

The participants learned, during the theoretical classes, the technical characteristics of mills, their auxiliary equipment, special features of roll design, organization and carrying-out of mill repairs and the basic indices of their operating efficiency.

In practical classes the participants studied, directly in the mills, particular features of equipment, the technology and organization of production and advanced methods and operational techniques.

The mills studied by the school are approximately of the same type. Each of them is served by one reheating furnace except for mill 500 of the Dzerzhinsk Works where there are two furnaces.

The mills are partly modernized. The roughing stand in mill 500 of the Dzerzhinsk Works is placed in a separate line; the remaining mills have tandem arrangement and have two or three working stands.

The speed of working rolls is varied on mill 600 in the Makeevka Works from 90 to 130 rev. per min.; on the finishing train of mill 500 in the Dzerzhinsk Works from 80 to 180 rev. per min.; and on the finishing train of mill 550 in the Petrovsk Works from 80 to 120 rev. per min. The roll speed in the mill of the Enakievka and Frunze Works is not varied.

The most various sections are produced on mill 500 of the Dzerzhinsk Works (more than 30 sections) and on mill 550 of the Petrovsk Works where a large number of periodic sections are rolled.

The main production indices of the mills are given in the table, from which it is seen that the smallest quantity of rolled product is produced by mill 550 of the Enakievka Works. The main reasons of lagging of this mill are the small capacity of the reheating furnace and the inadequate power of the main drive (1000 HP) so that the R - 18 rails have to be rolled in two stands only, which results in a lowering of the productive efficiency of the mill by not less than 25%.

Mill 600 of the Makeevka Works shows 80% of productivity of mill 500 of the Dzerzhinsk Works and has the highest idling percentage (up to 23.6%). This fact is explained by the out of date mill design and by the absence of mechanization which has been adopted on similar mills for a long time. There are no dragging devices for the transfer of the material from one stand to another, there are no lifting-rolling tables and plate tilters which should be installed at the front end of the reducing stand. The heating furnace of this mill is of a faulty design and hampers the production.

Main Indices of Medium-Section Mills Operation

Item	Works									
	Dzerzhinsk, mill 500		Petrovsk, mill 550		Makeevka, mill 600		Enakievka, mill 550		Frunze, mill 585	
	1955	6 mos. 1956	1955	6 mos. 1956	955	6 mos. 1956	1955	6 mos. 1956	1955	6 mos. 1956
Actual output of accepted product*	100	100	107.8	98 2	83.5	73.5	75.7	64.2	91.2	84.8
Target fullfilment, %	95.3	98.6	113.6	97.0	101,2	91.3	103.4	93.4	104.0	98.5
Hourly production in a busy time, tons	31.0	33.7	36.1	35.9	27.3	28.8	22.5	21.6	28.0	28.7
Idling, % of nominal time	15 4	14.2	16.01	14.9	16.0	23.6	10.3	10.5	9.5	9.8
Rejects, % of accepted product	1 0	0.9	0.88	1.23	0.89	0.61	0.4	0.2	0.54	0.50
Second grade, % of accepted product	0.5	0,7	0.73	0 82	1.6	1.0	1.6	1.3	1.3	1.7
Consumption:										
metal per ton of accepted product, kg/ton	1124	1126	1091	1098	1076	1068	1102	1111	1140	1136
conventional fuel, kg/ton	136	140	99	101	115	121	125	130	126	119
electric power, kw-hr/ton	52 8	52.5	36.5	37.6	27.4	26.2	8.8**	10.1	49.6	50.9
water, m^3/ton	19.3	18.4	27.1	25.7	10.2	9.0	37.1	36.0	22,8	21.7
rolls, kg/ton	4.9	3.0	3.0	3.0	3.5	3,7	8.5	6,1	2.6	2.5

* The output of mill 500 of the Dzerzhinsk Works is taken as 100%

** Mill 550 of the Enakievka Works operates with a steam drive.

A long time is spent on roll changing and mill adjustment. There are frequent idle periods because of the shortage of metal and of gas.

The best results were attained by the operators of the Dzerzhinsk and Petrovsk works. The mean hourly production of these mills is 33.7 and 36,1 t respectively. The smallest consumption of conventional fuel was attained in the heating furnace of mill 550 of the Petrovsk Works. The design of this furnace is very successful; an automatic regulator of gas - air ratio is installed here and it works well.

In mill 500 of the Dzerzhinsk Works the students studied in detail the progressive method of stand changing instead of roll changing; the rolls are mounted into a spare stand in the train of the mill and then the complete stand is changed. A member of the course, senior rolling operator on this mill, has achieved the carrying-out of this operation in a minimum time; his team changes one stand in 40 minutes and two stands in 55 minutes. The braces used for the prevention of coupling displacement are tied with rubber plaits. This shortens the time of tying.

The heating furnaces of mill 500 are modernized. The lower heating chambers are made 3 m deep; a separate gas take-off for the upper and lower gas streams is provided, the length of the furnace is extended towards the charging end, and the hearth is reduced from 7.5 to 3.7 m.

Gas burners, made in the works and having a low gas-stream resistance, are used. The longitudinal section of the furnace is shown on the diagram.

After modernization, the output of each furnace increased from 15 to 25 t/hr.

The gliding tubes in the furnace are thermally insulated. The insulation has been in use for over a year. In the welding zone the tubes are insulated with a mixture consisting of 15% aluminous cement, 60% chromite ore and 25% magnesite-roof brick rubble. In the soaking zone of the furnace a mixture of 25% aluminous cement or portland cement and 75% fire brick powder is used. For the support of insulation, aluminated steel projections 10mm dia are welded on to the sliding tubes. The concrete is made denser by means of an external vibrator of SI - 1 type.

In the Petrovsk Works, the course members studied the operation of mill 550. The heating furnace of this mill has been operating for two years without a major overhaul. The loading of the effective furnace floor constitutes 800 kg/m^3.hr and its output 50 t/hr. The proportionating of air and gas is made automatic; coke oven and blast furnace gas are supplied separately; the air to each zone of the furnace is supplied by a separate air duct; additional burners are installed in the upper and lower heating chambers in the welding zone of the furnace. The walls and roof of the welding zone are lined with chrome-magnesite brick.

separate air duct; additional burners are installed in the upper and lower heating chambers in the welding zone of the furnace. The walls and roof of the welding zone are lined with chrome-magnesite brick.

The inlet and outlet lines on the mills are attached to the beams by means of a cotter arrangement. Such a joint ensures satisfactory rigidity and facilitates a quick assembly and dismantling of these parts of the roll housing.

With a view to increasing the roll durability of finishing and pre-finishing stands, a layer made from powder wire is welded onto the rolls by the method of the Paton Institute of Electrowelding. The welding made it possible to utilize rolls which were rejected owing to their diameter reduction below the allowed limit.

The material in the rolling plants is controlled with regard to technological limits by the operating personnel of the section; this arrangement makes possible a considerable reduction of the personnel of the OTK (Department of Technical Control).

A distinctive feature of mill 550 of the Enakievka Works is a fairly small lifting table placed at the back end of the finishing stand. The electric motor of the table is mounted above the stand. Its installation does not require any large expenditure and facilitates the work of operators and increases the operating efficiency of the mill.

A special window is made in the heating furnace for the charging of incompletely rolled pieces. They are reheated for a subsequent further rolling.

Automation is introduced in individual sections of the mill. The mechanism for the lifting and lowering of the charge-window covering of the heating furnace is interlinked with the charge pusher, and the removing pusher is interlinked with the receiving reversible equipment and the roller conveyor in the furnace. The reversible equipment is of an original design suggested by the innovators of the plant. It consists of two driving rollers, one of which is mounted at an angle of 15° to the axis of the removing pusher. The billet placed on these rollers turns under the action of the force couple and falls between the two rollers down onto the removing roller tables. This arrangement eases the work of operators considerably and reduces the delay in delivery of metal to the mill.

In Mill 585 of the Frunze Works the course members acquainted themselves, in detail, with the operation of the cooler and also noted a rational solution to the problem of the removal of the trimmings from the hot-cutting press-shears by means of a chain transporter.

In order to increase the life of rolls, they are either welded-on or subjected to a surface hardening. The following measures are taken with a view to textolite economy: before mounting the rollers into the stand, the roll necks are polished on a special machine, special grooves are cut on the friction surface and on the face of the textolite bush, the grooves being then filled with babbit; the roll necks are lubricated with oil during the stand stoppages if they last more than 5 minutes; useable pieces of textolite for the composite bushes of the bearings are used again.

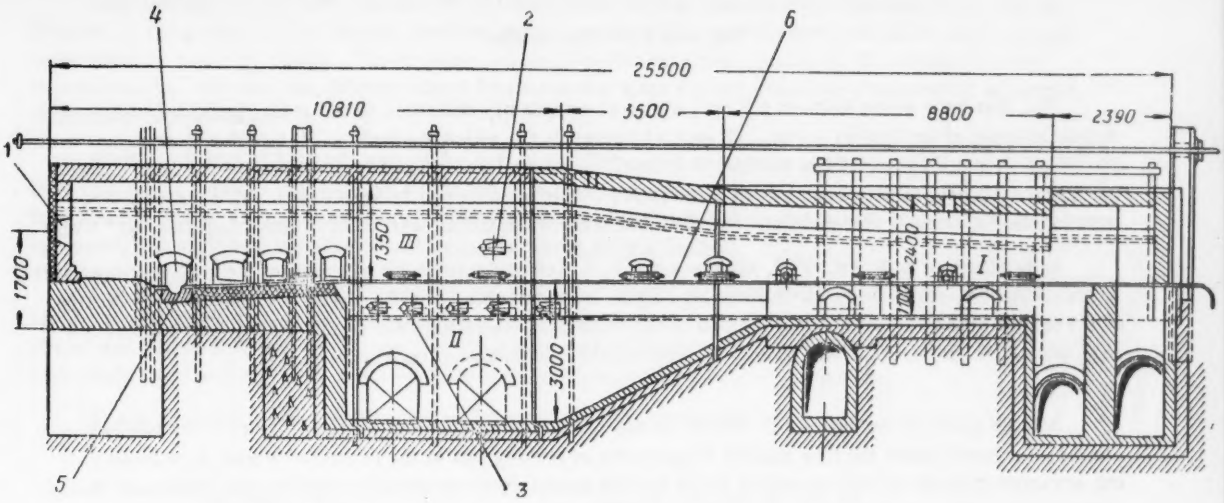
On the finishing stand of this mill, rolls with rough cast grooves are applied for the rolling of girder No. 14; these rolls have five times as long a life as the machined ones.

The school made favorable remarks on the working of mill 600 of the Kirov Works in Makeevka where mechanized arresters of a simple construction are installed behind the hot cutting saws, thus dispensing with manual labor. On other mills 2-4 workers at a time are engaged on the arrester.

During the final, summary classes the course, members discussed the advanced experience of section rolling mills, revealed the shortcomings in their operation and formulated concrete measures for each of the mills, aimed at the elimination of bottlenecks, an increase in operating efficiency, improvement in the quality of production and adoption of mechanization on various sections of the mills.

These measures are:

1. The increase in the thermal capacity of heating furnaces by introducting additional burners and by a better distribution of burners, by deepening the lower heating chamber and the removal from it of partition walls by the introduction of additional lateral gliding tubes and by thermal insulation of all the gliding tubes following the experience of the Dzerzhinsk Works.



Heating furnace of mill 500 at the Dzerzhinsk Works. I) heating zone; II) lower chamber of welding zone; III) upper chamber of welding zone; 1) furnace-end burners; 2) side burners of upper chamber; 3) side burners of lower chamber; 4) window for discharge of hot billets; 5) water-floor trough; 6) gliding tubes.

2. The development of more rational reduction ratios of the reduction and finishing stands with the aim of better utilization of rolls, reduction of the number of passes and the elimination of idle runs.

3. The modernization of out of date roll housings and systematization of their repair and maintenance.

4. The adoption of cotter fastenings on inlet and outlet lines on the model of mill 550 of the Works.

5. The adoption of the hydraulic and mechanical methods of scale removal from underneath the stands and auxiliary equipment of the mills.

6. The mechanization of the operation of arresters situated behind the hot cutting saws, on the model of mill 600 of the Makeevka Works.

7. The binding of braces mounted on the coupling spindles, with rubber plaits, for the prevention of displacement of the coupling, on the model of mill 500 of the Dzerzhinsk Works.

8. The adoption of stand change instead of conventional roll changing, on the model of mill 500 of the Dzerzhinsk Works.

9. The mechanization of heavy and labor consuming operations on grading and sorting of finished rolled product..

10. The transfer of quality inspection during the operation to the mill workers, following the practice of the Petrovsk Works.

11. The remuneration of mill operators and welders on a complete change inside a shift is to be made dependent on the output of each substituted team (half team), following the practice of the Frunze Works.

12. The adoption, on the rolling mills, of the advanced techniques of the senior mill operator of mill 550 of the Dzerzhinsk Works, V. A. Sadlov, and of the senior welder on mill 585 of the Frunze Works, P. V. Moskalenko.

DNEPROPETROVSK BULLETIN OF TECHNICAL INFORMATION

Engineer E. P. Shevchenko

The first issue of the Bulletin (52 pp.) is almost completely dedicated to the actual problems of the ferrous industry of the Dneper region. Of special interest is the article by Prof. A. D. Gotlib and Asst. Prof. G. A. Volovik, describing a method, developed by themselves, of automatic control of the blast furnace operation according to the pressure drop between the cyclic air duct and furnace throat. This method, constituting the first step in the automation of the blast furnace operation, was tested at the "Zaporozhstal" Works.

N. M. Chuiko, A. P. Em, V. S. Kurganov and E. I. Kadinov related the experience of the "Dneprospetzstal" Works on the treatment of steel with reducing slag in the ladle, this method allowing a considerable reduction of the sulfur content of metal. This method of de-sulfurizing low-alloy steel can be successfully applied not only in electric furnaces but also in open-hearth furnaces and Bessemer converters.

A large space in the Bulletin is allotted to the "Forum of advanced experience". Here A. Staroselsky and Ya. Karmazin relate the new method of operation of soaking pits at the Petrovsk Works, A. Nikulin - the advanced methods of mill operating teams in tube manufacture on the pilger mill at the Liebknecht Works, G Borisenko - the new method of adjusting the guiding equipment of the wire mill at the Petrovsk Works; and other articles.

The majority of the articles in the first issue are written by workers from the plants, the material is arranged in a simple and readable manner. The issue, however, is not entirely successful: some articles contain obsolete information, it is mainly the work of the Petrovsk Works which is described, although there are ten metallurgical works in the Dneper region:

We must hope that the subsequent issues of the "Bulletin of Technical Information" will illustrate more fully all the modern advances of the metallurgical works of the Dneper region.

GROUND-LEVEL, TURNING, LOADING MACHINE

P. K. Kuznetsov, I. M. Basalaev

Guryev Metallurgical Works

At the Guryev Metallurgical Works - on the suggestion and by the design of the senior designer of the Technical Department of the Basalaev Works - a ground-level turning machine was built and installed in 1952 for the loading, into covered railroad cars, of small articles which are liable to interlink (railroad cotters, cover plates, backing telegraph hooks, balls of the coal mills etc.). Because of interlinking these pieces cannot be charged into cars by bunkers or chutes, so that prior to the adoption of the machine such material was loaded into cars by means of shovels and forks or in separate parts and bundles.

The loading machine (Figure) consists of iron construction in the form of a semi-ring (1) joined firmly to the centre of rotation by the pivot (2). The semi-ring is supported, in its middle part, by one driving wheel (3) resting on a rail (4) bent into a semicircle; a stable position of the semi-ring is attained by means of a guide rail (5) with two supporting rolls (6) and pivot (2) through the connecting arm (7) of the semi-ring with the pivot; at the ends of the semi-ring there are forks with grooves for the trunnions of the containers.

On the connecting arm (7) are mounted the electric driving gear, the control levers and the seat for the operator. By means of the driving wheel the semi-ring executes 90 degree turns in one or other direction at a speed of 15 m/min. There are buffers at the ends of the rails. The electric motor is connected with the driving gear through an automatic friction clutch.

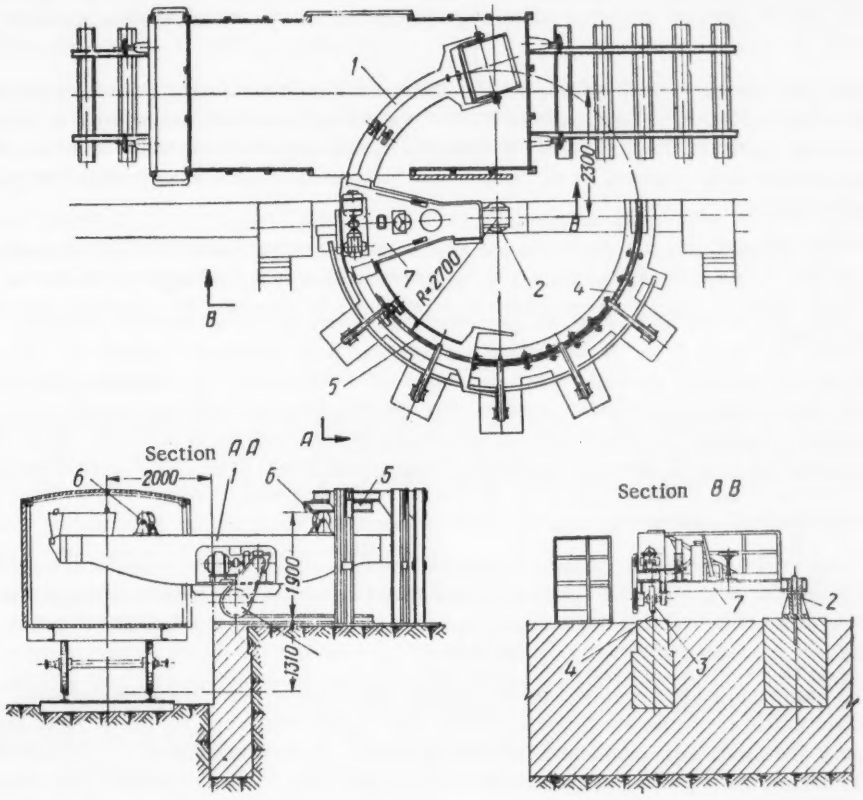
The machine is set by the railroad track on a platform provided with an overhead electric crane. The material is delivered to the platform in containers of 0.63 cu. m volume. Covered railroad cars are placed at one side of the axis of the loading machine. During the loading the cars are displaced by means of a scraper hoist.

After placing the car door opposite the left fork of the loading machine, the container is set with its trunnions in the grooves of the loading machine forks by means of the electric overhead crane and is secured in the forks by a special clamp. The operator switches the electric drive, introduces the container in the required position into the car, lifts the clamp by means of a lever and the container is overturned as a result of trunnion displacement.

After the filling of the right part of the car, it is pulled while still in the train, by means of the scraper hoist into such a position that the door of the first car is placed opposite the right fork of the loading machine; then the left side of the car is loaded. By moving the whole train in one direction with intermittent stops for loading the right and left sides of each car, the whole train is loaded.

The machine is simple in construction and reliable in operation. The adoption of the ground-level turning machine has made a full mechanization of loading possible, has considerably decreased the idling of cars and has reduced the cost of loading. Thus, the cost of loading of 1 ton of balls decreased from 3 rubles 23 kopecks to 93 kopecks, that of cotters from 3 rubles 23 kopecks to 1 ruble 11 kopecks.

By the adoption of this machine the works saved over 48,000 rubles.



Ground-level, turning, loading machine.

OUSTANDING METALLURGISTS

P. P. ANOSOV

Cand. of Econ. Sci. A. V. Leskov

The great Russian metallurgist, Pavel Petrovich Anosov, was born in 1799.

His father, who had served as a secretary in the Berg-College, when he died left four young children. Two of them – Pavel and Vasily-were placed in the Mining Military School by their grandfather, Sabakin, who worked as a mechanician in the Kamsk Works.

On graduation from the Mining Military School with distinction, Pavel Anosov arrived, at the end of 1817, in Zlatoust for a two year practice. At that time Zlatoust was a small town with a population of 16,000. Steel was produced on the Zlatoust Armory Plant by working raw cast iron under a hammer. This steel was used for a limited production of blank weapons. In the "ornamental" shop of the plant the artist-engravers put gold ornaments on the blades.

At that time Zlatoust, Kusin, Satka, Artin and Minassk plants had just passed from private to state ownership and formed the Zlatoust Mining Region. Many German specialists were working at these plants. Many of them did not know much of armory art and started to learn it only in Zlatoust. The Germans were much better paid than the Russians.

Even before the end of his practice period, in October 1819 Pavel Anosov was given the position of superviser in the department of ornamented weapons. His interests, howe ver, were not limited to the plant. Anosov studied with enthusiasm the possibilities of prospecting natural resources of the Urals. In the fifth issue of the "Mining Journal," in 1826 appeared his article "Geognostical Observations on the Ural Mountains, situated in the Region of the Zlatoust Plants." It was the first published work by Anosov and it was followed by numerous other geological works of his.

At the same time he took active interest in the problems of the plant and developed a new design for cylindrical bellows. At the end of 1824 Anosov became director of the plant. He then met Pavel Nikolaevich Shvetsov, a steel expert, who came to the Zlatoust plant from Tagil. Anosov, together with Shvetsov, decided to find a method for production of cast steel in crucibles.

Crucibles were supplied at that time from the German town Passau. They cost 25 rubles each. For a long time Anosov tried to find the secret of why Passau clay is such a good refractory. He finally found that "in Passau pots nature itself took care to combine clay with graphite." Anosov then mixed Chelyabinsk clay with screened coal fines and old crucible chips and obtained a refractory clay, not at all inferior to the Passau clay. The crucibles made of this clay cost 44 kopeck each.

In these crucibles Anosov began to prepare cast steel from iron scrap. In contradistinction to the old method, the carburizing of this steel was carried out by a method of gas carburizing. This fundamentally new method of cast steel production was described in the article "Preparation of Cast Steel" by Anosov, and published in the "Mining Journal."

Then P. P. Anosov entered upon the realization of his life dream ,the production of Russian "bulat" (damask steel).

At that time the secret of making damask steel – a blade made of it was worth a herd of horses or hundreds of tchervonetzs (gold pieces) – was lost. Metallurgists all over the world attempted to discover the secret. However, all the experiments of Faraday in England, Karsten in Germany, Rinman in Sweden, Bertier in France and other West European scientists were unsuccessful. Only Anosov succeeded in discovering the secret of damask steel.

In the course of several years Anosov, together with Shvetsov and other Russian specialists, spent days and nights at furnaces, studying charging, melting and cooling of steel and constantly noting the temperature and supply of air to the furnaces.

At last the problem was solved – a blade, made of produced "bulat" steel, could be freely bent into a semicircle, and would cut through an excellent Solingen saber without notching. At the same time the blade had a remarkable ornamental pattern obtained in the process of manufacture. Anosov's steel, owing to its unparalleled properties, made Russia's name famous all over the world.

In 1841, Anosov published his classical work "Bulat" which was immediately translated into German and French. This book starts with the definition of bulat: "the word "bulat" is accepted by every Russian to denote a metal harder and sharper than conventional steel." Anosov was not referring to the conventional high grade steel which was then made in many countries, but to the "attainment of perfection in steel." Forseeing a promising future for such steel, he wrote:...."soon our farmers will till the soil with bulat implements, our artisans will make their goods with bulat tools."

Anosov studied the physical structure of the metal and its chemical composition thoroughly. He applied a microscope for the first time to the study of metals. Preceding the English scientist Sorby by 33 years, Anosov laid the basis for the microanalysis of metal and for metallography, without which modern metallurgy would be inconceivable.

Anosov described all the stages of metal production: melting, casting, forging, thermal and mechanical treatment, its quality control according to macrostructure, microstructure and mechanical properties. He learned a lot from the specialists – Shvetsov and Utkin.

The principles of the steel-making technology, developed for the first time with such thoroughness and scientific conscientiousness, constituted promising and firm foundations on which the present day metallurgy of high grade steel is based.

In the course of experiments on the production of bulat, Anosov studied the effect of manganese and chromium – additions frequently applied in our times - on the quality of steel. During the investigations he tried to add gold, silver and platinum to steel but soon discontinued these experiments as they lacked promise.

Anosov succeeded in proving that bulat steel consists of iron and carbon only. Its principal distinction from ordinary steel lies in its structural non-uniformity.

On the crystallization of bulat steel, the components with a higher melting point crystallize out in the form of dendrites – branchy crystals. These dendrites are covered with a layer of softer and lower melting point components. Such a combination of hard and soft iron provides for the extraordinary hardness and elasticity of bulat steel. On etching such steel, the soft components are etched and the hard components remain, producing a pattern. If, however, the steel is heated to a very high temperature and then rapidly cooled, no patterns are obtained.

After Anosov's time this was shown by a great Russian metallurgist – D. K. Chernov.

Anosov solved the problem of the effect of carbon on the quality of steel and its crystallisation in a fundamentally novel way. He rejected as completely unnecessary the mystic additions to steel of diamonds, ivory and wild flowers, and replaced these additions by ordinary graphite – the most simple carbon source.

In 1831, Anosov was appointed Head of the Zlatoust Mining Region. He introduced steam engines on many plants; he worked out new regular schedules for the plants and new norms of production. Anosov endeavored to ease the intolerably heavy work of serf-laborers.

P. P. Anosov was an all-round educated engineer. He contributed a great deal to the development of the mining industry in Russia and, in particular, he was the first to prepare a geological section of the Ural from Zlatoust to Miass. These fruitful geological works, successful prospecting and discovery of new deposits, contributed to the expansion of the raw-material basis for the home metallurgical industry.

Anosov put considerable effort into the development of the gold extraction industry. He invented a gold-washing machine and introduced it into the Miass gold field. Anosov proposed and put into practice a bold project of gold recovery by means of mass remelting of gold-bearing sand.

In 1847, Anosov became Chief Director of the Altai Mining Plants and Civic Governor of the Tomsk Province. Here he continued the improvements of the mining industry. As the governor, Anosov looked after the improvement of public education, the development of municipal local government and town planning. He died, after a cold, on 13th May, 1851, in the prime of his creative life.

More than 100 years have passed since Anosov's death but many of his ideas are still alive even now. Their longevity is ensured by the very close relationship of Anosov's scientific research with life and practice, and his endeavor to put science at the service of man.

On the bold experiments and researches of Anosov were educated many gifted engineers and scientists who contributed several valuable discoveries to the field of metallurgy. Zlatoust became a school of Russian metallurgists.

A. S. Lavrov and N. V. Kalakutsky, who discovered the segregation and blow holes in steel ingots, the principles of the development of these defects and methods of prevention, began their fruitful work on the Zlatoust plant.

Uznoskov, who was the first to introduce the open-hearth process in Russia, worked on the Zlatoust plant.

When Anosov was appointed Director of the Altai plants, his successor on the Zlatoust Plant, P. M. Obukhov, cast for the first time in Russia a steel cannon by following Anosov's methods. Zlatoust steel produced by Obukhov was 18 times cheaper and 30 times stronger than that made abroad.

The tsar, present during tests of this cannon, expressed his fear that it would explode on firing. Then Obukhov, having complete confidence in the quality of the metal he produced, said that he was prepared to sit on the barrel of the gun during firing.

Obukhov's cannon withstood 4,000 firings.

In 1859, on the Zlatoust plant, V. S. Pyatov produced steel armor for the first time in history.

During the years of the Great Patriotic War Zlatoust metallurgists supplied the Soviet Army with high grade steel not only for saber blades but also for tank and aircraft engines, thus making victory over Hitler's well-equipped army possible.

Relying upon the recent advances of modern science, Zlatoust metallurgists now make — in an electric furnace — high grade steel for the most complex equipment of the many branches of the national economy of the USSR.

Anosov's name has not been forgotten; his works have been published, Anosov prizes for outstanding works in the field of metallurgy and Anosov scholarships for students have been established. A monument to the great metallurgist has been erected in Zlatoust.

His best monument is however his scientific heritage in which the discovery of the damask steel secret is a pearl.

Anosov bulat has been replaced by new steel and alloys of most various grades, ensuring the operation of steel equipment at high temperature, at high speed, at high pressure and resistant to acids and alkalis. Utilizing Anosov's studies, Soviet metallurgists ensure the production of engines, machines or apparatuses, of most complex design for operation under most difficult conditions.

FROM THE HISTORY OF TECHNOLOGY

BEGINNINGS OF THE IRONMAKING INDUSTRY

V. B. Yakovlev

About seven to eight thousand years ago man began to utilize native metals, and the smelting of copper was developed six thousand years ago. Some thousand or two thousand year later bronze (copper-tin alloy) became a widely used metal for the making of weapons and production tools.

As a result of an accumulation of experience, the production of metal gradually developed and improved. The first furnace for the smelting of metal from ore was probably a simple camp fire covered with ore lumps. Later on, to accelerate the process, artificial blast was applied. In Egypt, 3300-3500 years ago (XVth-XIVth centuries B. C.), blast was applied in the furnaces (small shafts, covered by stones) either by very crude bellows or even by tubes into which several men blew (Fig. 1).

Rich copper ore deposit, suitable for easy processing with the techniques of that time, was very rare, and therefore it took a long time before copper and its alloy replaced stone.

At that time man did not yet know how to smelt iron although iron reserves in the earth crust are enormous compared with other metals. Geologists estimate that in the earth's crust to a depth of 16 m from the surface, there is about 5% iron. According to the distribution of elements it is placed only after oxygen, silicon and aluminum. Iron occurs in chemical compounds and only very rarely can native iron - in the form of grains embedded in basalt or in sand together with gold and platinum - be found.

Fig. 1. Ancient Egyptian furnace.

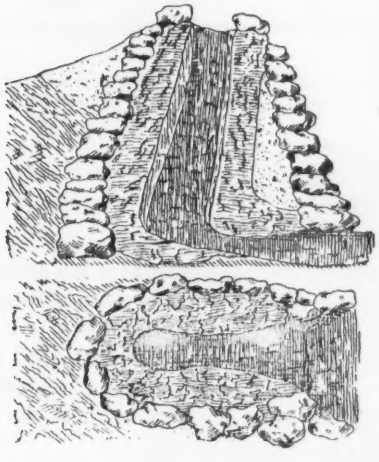


Fig 2. Section through a primitive blast furnace.

Most likely, man initially came across not native iron but so-called meteoric iron which he found as fragments "from heaven". A distinctive feature of this iron is its high nickel content. In several countries, mainly those near the equator, archeologists found iron articles which were estimated to be four, five or even six thousand years old. As meteoric iron was very rare, the value of iron was equal to, or sometimes higher than, gold and silver.

The process of iron production from ore was mastered about three thousand years ago on the verge of the second and first millenium B. C. It is difficult at present to determine precisely the time and place of the first successful attempts to produce iron from ore.

The development of the iron industry was relatively slow and took place in different countries at different times.

While the peoples of the middle East, India and Southern Europe began to smelt iron at the end of the second and the beginning of the first millenium B. C., the tribes of Northern Europe began to master that process only in the VIIth century B. C., the Egyptians in the VIth century B. C., and the people of the Far East in the VIIth to the Vth century B. C.

Apparently Caucasus should be regarded as the place where iron production first originated. Later on, in about the Xth century B. C. iron smelting was practiced in the Upper Volga region.

At roughly the same time iron smelting began in Central Asia and somewhat later in the neighboring regions of South Siberia and Altai.

The mastering of ironmaking is one of the great achievements of mankind.

The iron industry accomplished an enormous revolution in the development of technology. One can appreciate this by one simple fact - a big tree can be felled in a few minutes with an iron axe while it took some two months to cut it with a stone axe. Iron tools very soon displaced stone ones.

As yet, it is difficult to establish how man learned to smelt iron, but from some indications it is possible to form a picture. Probably the first iron was smelted by chance. Frequently the fire, over which man prepared his meals, was surrounded for wind protection with stones, among which an iron ore lump could get by chance. Under the prolonged action of the heat of the fire and the reducing gases produced by burning wood, metallic iron could gradually appear. The lustre of iron and the fact that it could be forged into a desirable form by means of stone not only in the hot but also in the cold state, drew primitive man's attention. It gave him an incentive to search for the "stones" from which iron could be obtained.

A proper preparation of the ore (roasting, washing and grading) and the use of charcoal instead of wood made the iron smelting considerably easier and contributed to a great extent to the development of metallurgy. Blast played an even more important part. With the application of blast and the development of larger capacity blowing equipment, the scale of the iron industry grew.

In many cases the iron industry appeared in places where the technique of bronze-making was already highly developed. Therefore the first equipment and methods of production were similar to the old ones. Shallow shafts in the earth, somewhat reinforced with stones,served for a long time as crude furnaces for iron making from ores. Such furnaces built in habitable dwellings existed for a very long time without any modifications. Very frequently specially prepared crucibles or old earthenware pots with side openings for bellows air inlet served as the working volume of such furnaces. Furnaces of such a type were still in common use n Germany in the XVIth century, in France in the XVIIth century and in some backward regions of Africa and other places in the XIXth and even in the XXth century. The furnaces were small in size and in them iron cake - so called bloom -less than one kilogram in weight, was produced.

Similar pits in the earth were also made outside the home hearth ("wolf-holes"). In the process of development they were gradually converted into furnaces which were called "raw blast furnaces" (Fig. 2). In such cases no blast bellows were used; air was supplied to the firing zone as a result of either natural draft or wind. Therefore the height of the furnace and correspondingly also the other dimensions were gradually increased.

In hilly countryside the furnace was built on a slope (Fig. 3) taking into account the direction of wind which would provide blast for the furnace.

Pits, in the form of vertical shafts bending at a right angle in the lower part, were dug out on the slope of a hill; the inside of the shaft was laid with stones.

Soil and sand were the only supports for the stones. For the removal of the bloom it was necessary to wreck practically the whole furnace. Similar furnaces were also built in low-land places where suitable slopes were found.

Later on, clay was used for the reinforcement of the furnace walls and with this method it was possible to erect stable furnaces (Fig. 4) above ground level instead of simple pits. It was a great advance, making possible not only the erection of furnaces but also an increase in their height. According to archeological excavations, such furnaces were in use on the territory of the USSR beginning from the IXth century. Some furnaces were built of clay alone. For instance, the preserved furnace of the Labinsk ancient stronghold in Byelorussia is of an arch shape in section, the height of the roof is 35 cm, internal width of the furnace is 60 cm, the thickness of the clay walls is 5-10 cm.

Further extension of furnace size could not be accomplished without the introduction of artificial blast. Hence the furnace was equipped with a hand bellows (Fig. 5). Such a furnace used to be called a "domnitsa" (from the slavonic word "dmati" - to blow). These furnaces began to be used in our country approximately in the IXth century. The weight of blooms found near those furnaces was 3-4 and even 5 kg.

It is interesting that iron produced in this way is very pure and has very few extraneous contaminations. The explanation of this fact is that during the reduction process in the furnace there is no time for the total bulk of silicon, manganese and phosphorus to be reduced and they are converted into slag, while iron for the most part is converted into metallic state. Consequently, an iron bloom enveloped in slag is obtained in the furnace.

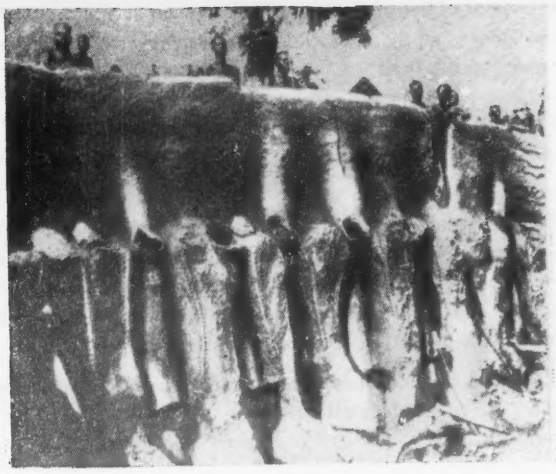


Fig. 3. Raw-blast furnaces in Africa.

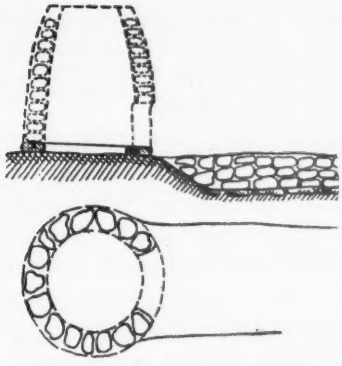


Fig. 4. Old Russian blast furnace(section and plan).

In such a "raw-blast" process not only silicon, manganese and phosphorus, but also iron, is incompletely reduced. Therefore, slags in such a process contain a large amount of iron oxides (sometimes up to 50%). There are known cases where these slags were used instead of ore in large quantities in blast furnaces for the production of pig iron.

It was not yet possible to manufacture various articles from bloom, made in the raw-blast furnace The early bloom was porous and weak and in a later period it was necessary to break it into small lumps before use. The metal obtained in these early furnaces was then forged with the object of removing the slag and strengthening the metal.

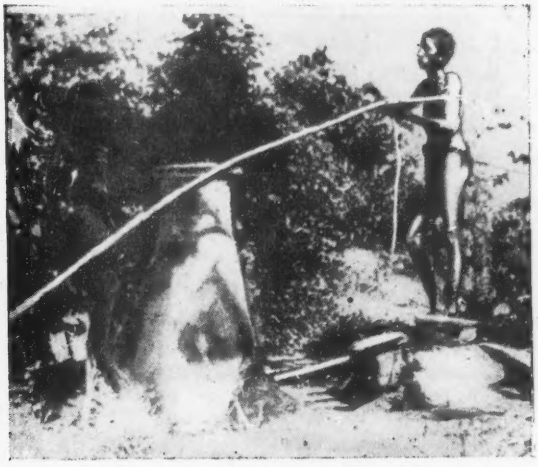


Fig. 5. Raw-blast furnace with bellows.

Simultaneously with the development of the production of soft pure iron, man learned how to improve its properties. In Russia, even before the Mongolian invasion, there were various iron articles made by involved methods of melting, hardening and quenching, in use.

As a result of the application of blast bellows the size of the blast furnaces increased. The capacity of the blast bellows increased correspondingly. In the XIVth - XVth century such furnaces in Western Europe were over 4 m. high.

In the course of development the construction of the furnaces changed radically. While in early times it was necessary to break the furnace almost completely in order to remove the bloom, now an opening was made in the lower part of the hearth for the removal of the bloom. It was no longer necessary to break down the furnace, hence new requirements became apparent with regard to the quality of furnace walls. The furnaces were made more sturdy, and stronger building material was used.

The increased size of the furnaces and of the bellows forced man to make use of various mechanisms and animals and then of water energy to facilitate the air blast delivery. The adoption of water motive power in the iron industry made possible a further increase in the size of furnaces and the extent of production.

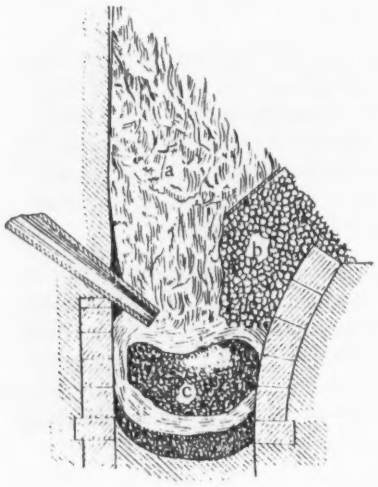


Fig. 6. Catalan furnace:
a) charcoal, b) ore, c) metal.

In connection with the change of the reducing conditions of iron, the slag content of carbon and of other impurities increased Together with crude bloom, pig iron, properties of which were initially unknown, began to appear in high furnaces. At first it was regarded as useless and rejected; here and there it was called "pig iron" (as in English).

Later on, metallurgists noted and began to make use of the casting properties of pig iron. Pig iron was used for making various articles. Then the process of refining pig iron into wrought iron was finally developed. A new stage in the development of metallurgy was reached

New blast furnaces did not at once displace raw-blast furnaces. On the contrary, in some places the production of raw iron came back into its own on the basis of more advanced metallurgical methods. For instance, in the XIXth century, in some countries the so-called Catalan forge (Fig. 6) - which in its principle of operation was a raw-blast furnace using bellows and hydraulic power drive - was widely in operation. This process, however, did not last for long. New, more economical methods of metal production finally displaced the old methods.

Some problems of the development of ancient iron-making methods are not sufficiently clarified. Further research in this field should assist in an accurate determination of the time of transition from one stage of development to another and in the establishment of the geographical distribution of the iron industry at various times.

METALLURGY ABROAD

CORNIGLIANO WORKS IN GENOA

I. G. Bukhovstov

The Cornigliano Works is a modern integrated works with a complete metallurgical cycle, specializing in the manufacture of steel plate in the form of brick plate, hot and cold rolled thin steel sheet as well as tin plate and galvanized product in coils and separate sheets. By the volume of the output (850,000 tons of ingots) this is the largest metallurgical works in Italy.

On the sinter plant there are two Dwight-Lloyd type machines each with 30 m^2 surface. The sinter is the fluxed agglomerate of basicity 2 and iron content of 52-53%. In the preparation of the agglomerate, pyrite cinders are used which contain 3-4% sulfur (sulfur is nearly completely eliminated on agglomeration). Mean iron content of the ore charged to the blast furnaces constitutes 60-65%. Up to 50% of fluxed agglomerate is added to the blast furnace charge.

The coke oven plant has two Otto batteries of 28 ovens each and a by-product chemical plant. Small size coal is imported from the USA and is charged into the ovens without any preliminary treatment. The plant produces 1400 tons of coke per day. The coke is graded: 40-150 mm fraction is used in the blast furnace and the fraction below 40 mm is crushed and used in the sinter plant. The blast furnace coke contains 0.6-0.7% sulfur and 8-9% ashes. Both batteries are operated by 15 workers per shift.

The blast furnace plant. Two blast furnaces (Fig. 1) are operating on the plant with a capacity of 1500 tons of pig iron per day. At present one more furnace of 1200 t/day capacity is being built. The operating

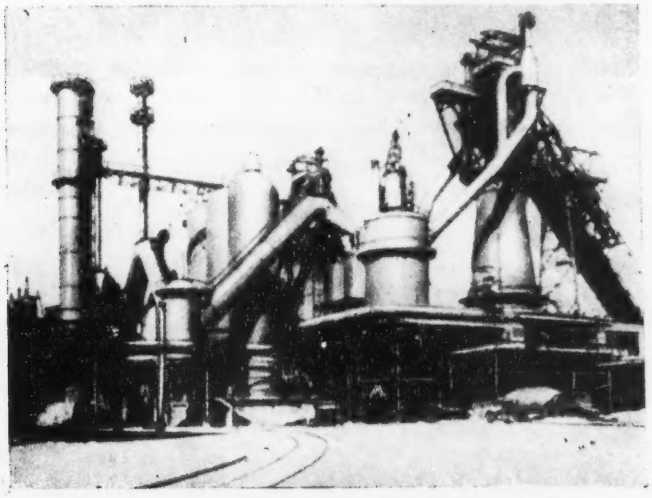


Fig. 1. Blast furnace plant of the Cornigliano Works.

furnaces have 5 air heating stoves, 33 m high and 7 m diameter, with an effective heating surface of 17,000 m^2 each (two stoves for each furnace, while one is being repaired). The well and the hearth of the furnaces

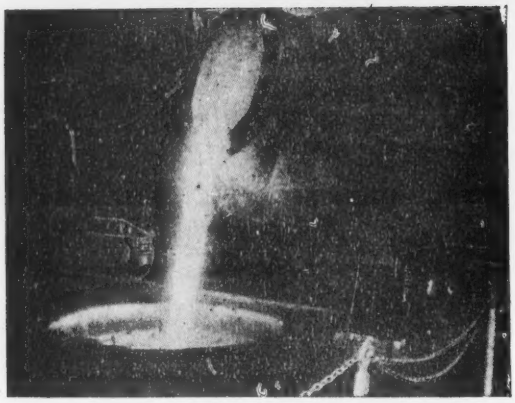


Fig. 2. Mixer-type ladle for transportation of hot metal.

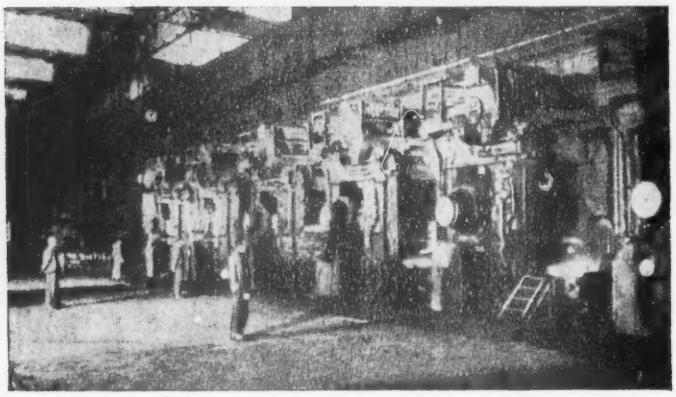


Fig. 3. Continuous, six-stand mill, made by the firm "Mesta."

are lined with carbon blocks, the inside is filled with high-aluminous brick. The blast furnaces are operating at an increased top pressure of 0.9 atm, the temperature of the blast being 800° C. Coke consumption is 600-800 kg per ton of pig iron, limestone consumption 180-300 kg, blast furnace dust loss reaches 70 kg, and slag produced — 600 kg.

Pig iron composition, %			
Si	Mn	S	Cu
1.0	1.6-1.8	0.03	0.08

The steelmaking plant. The steelmaking plant consists of: charge yard equipped with grab and electromagnetic cranes; charging side; furnace floor with six 200 ton open-hearth furnaces, two pouring cranes of 150 ton load capacity, three 10 ton charging machines and three filling belt machines; pouring floor with two pouring cranes of 270 ton load capacity; and the mold yard.

The open-hearth furnaces have a bath 22 m long, 6 m wide and 1.5 m deep. Roofs are of Dinas (silica) brick whose life is 110-160 heats. The furnaces are fired with the coke oven gas with an addition of fuel oil; steel is made by the scrap-ore process. The charge to the open-hearth furnaces contains 60% molten hot metal.

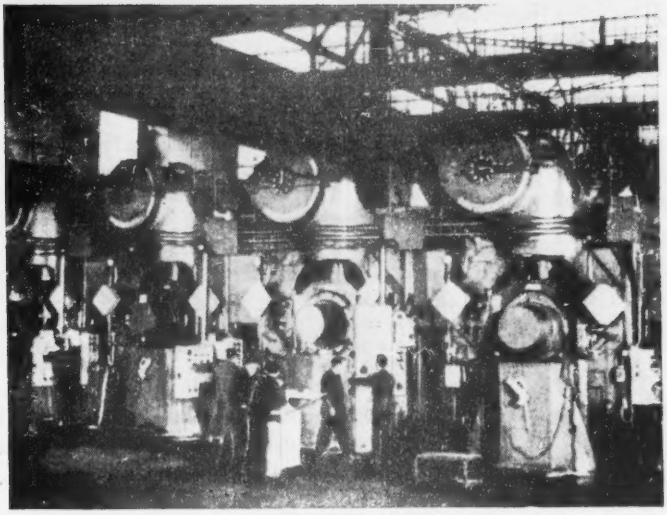


Fig. 4. Four-stand, four-high, continuous mill for cold rolling, made by the firm "Continental".

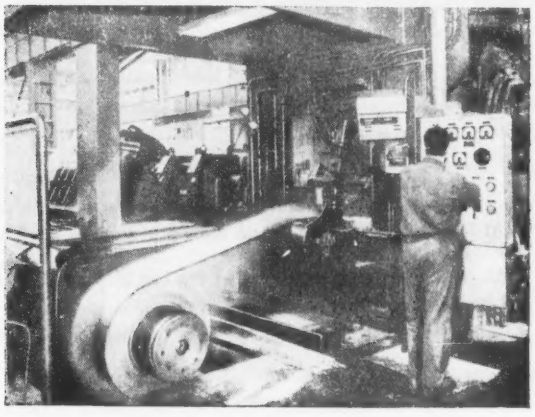


Fig. 5. Four-roll, reversible mill for cold rolling.

There are no mixers on the plant. Hot metal from the blast furnace plant is transported in mixer type ladles of 200 ton capacity (Fig 2) to the furnace floor where hot metal is poured into ladles for charging into open-hearth furnaces.

The plant makes mainly rimmed carbon steel. The production of killed and semi-killed steels does not exceed 30% of the total steel output. The duration of the heat of a 220 ton batch is 9-9.5 hrs.

Steel is cast from above into flat molds, mounted on cars. The weight of the ingots is up to 14 ton. The banks to the charging doors are repaired by means of autocars provided with a large trowel. The autocar scoops fettling materials with the trowel and throws them onto the banks. Bank repairs are thus considerably simplified. Such a method of repair should be adopted on our plants.

For the cleaning of molds there is a special equipment—steel brushes which are fixed to a hook on the stripping crane in the mold yard. The brush is provided with special springs which press it against the wall of mold. After cleaning, the molds are lubricated with graphite and water.

Motor cars, loading machines and motor trolleys are extensively used in the plant.

The blooming plant. For ingot rolling there is a Schloeman blooming mill 1000. The length of the roll body is 2900 mm, the mill is driven by an electric motor of 8000 H. P. Ingots are heated in regenerative pit furnaces (six groups). In each group, consisting of two chambers each, 180 ton of ingots can be placed. Rolls are of American design, with plain bodies and with housing grooves at the ends.

The blooming mill output of 850,000 ton per annum does not ensure a further increase in sheet steel production. It is intended to replace it by a blooming-slabbing mill with 1150 mm dia rolls and driven by two electric motors with a combined H. P. of 10,000.

After the blooming mill there are enclosed type, "Mesta" made, 2000 ton capacity shears which cut blooms of up to 400 x 400 mm section. Discarded shearings are removed by a conveyor to the adjoining floor where they are thrown into containers placed in pits filled with water.

After going through the shears the slabs are transferred to the next floor where they are stocked, inspected, and their surface defects removed.

Universal reversible four-high stand. After the removal of surface defects, the slabs are transferred to two reheating furnaces of 80 t/hr capacity. The furnaces are fired with a mixture of blast furnace and coke oven gas.

A third furnace of 100 t/hr capacity is under construction.

The universal reversible four-high stand, with 658 dia and 3000 mm body length work rolls, serves for rolling plates up to 2700 mm wide and as a roughing stand prior to the continuous four-high group of six stands. On leaving the universal stand the stream of metal is divided: thick plates are taken by transporters to the adjoining floor and thinner metal is transported on table rollers to the six-stand continuous mill.

The continuous, six-stand, "Mesta" made mill (Fig. 3) has a scale breaker and a continuous group of 6 stands (rolls with approx 2000 mm long body) in which thin steel plates, 1.8 - 5 mm thick and 1780 mm wide, are rolled. The speed of rolling is up to 9 m/sec.

Working rolls are mounted in roller bearings, the backing rolls have liquid friction, Morgoil type bearings. A change of working rolls is carried out depending on the volume of production; an overall change of rollers on the mill is done after rolling 4000 ton of metal and the backing rolls are changed once a week.

Beyond the finishing stand there are cooling table rollers where the thin steel plate is cooled with water delivered at 70 atm pressure. The table rollers are divided into three sections with different conditions of water cooling depending on the thickness of the cooled metal. Water is sprayed onto the plate from above and below by means of sprayers.

Beyond the cooling table rollers there are two coilers. Usually one coiler is used for coiling good product and the other for coiling rejects. The coils are weighed on Morse scales and then are transported to the cold rolling plant.

Parallel to the main floor there is a finishing and packing floor for the hot rolled thin steel plate. This floor contains the following machinery:

1. A machine for cutting coiled steel into sheets.

An interesting part of this machine is a radial apparatus for sheet width control. After weighing each packet of sheets is provided with a certificate giving the size of sheets, the tolerances, the grade of steel and the thermal treatment. This document accompanies the packet of sheets until its delivery to the consumer.

2. A dressing stand for the dressing of sheets in coils at a speed of 300 m/min.

3. A machine of the Etna-Standard firm with the usual equipment for longitudinal cutting of coils.

Sheets are packed manually with a very simple gadget for bending the binding strip. Some of the packets are bound with binding strip only and some are covered on the sides with a sheet bent into a channel form; the top and bottom of the packet is covered with rejected sheets and then all is tied both ways with the packing strip.

Rolled Sheet Steel

Product	Thickness, mm	Width, mm	Length, mm	Maximum weight, kg	Remarks
Slabs of maximum section 3000 cm^2	–	–	—	10,500	Not pickled
Universal billets and wide plate	9-32	Up to 2800	Up to 20,000	Up to 5250	Pickled
	5-9	Up to 1800, as required to 2800	Up to 6,000 Up to 18,000		
Hot rolled sheet	2-5	Up to 1800	Up to 6,000		With trimmed edges
	1.8-1.99	Up to 1250	Up to 18,000		Without trimmed edges
Not pickled	2-5	Up to 1800	—		
	1.8-1.99	Up to 1250	—		
Cold rolled sheet	0.3-0.49	Up to 1000			Trimmed and cut into sheets; white annealed by usual method and for deep, medium and very deep drawing
	0.5-0.79	Up to 1250	650—4500		
	0.8- 3.0	Up to 1250			
Cold rolled sheet steel in coils	0.3– 0.49	Up to 1000	—		Untrimmed, white annealed and for medium, deep and very deep drawing
	0.5– 0.79	Up to 1250	—		
	0.8– 3.0	Up to 1500	—		
Tin plated sheet	0.3- 0.49	Up to 1000			
Galvanized sheet	0.5-1.5 -2.0	Up to 1200	650—4500		Untrimmed, normalized, annealed for medium and deep drawing
Tin plated and galvanized sheet (Sendzimir patent)	0.3-0.49	Up to 1000	—		
	0.5-1.5	Up to 1200	—		
Hot tin plated sheet	To 0.2 and even 0.15	To order			

Both sections are kept very tidy, the floor in the main section is made of metal and in the finishing section - of reinforced concrete blocks covered with mastic. Coils are stored upright, in a single layer; between the coils there are wide passages; the coils are transported by self-loaders of 14 - ton loading capacity.

The cold rolling plant is housed in a separate building.

A continuous pickling train of thin steel sheet of up to 1500 mm width, includes machines for butt welding and jointing the ends of coils to ensure continuous operation, and four baths for pickling and washing the strip. The pickling is done in 7 - 12% sulfuric acid solution, the acid consumption being 20 kg/t.

A four-stand, four-high, continuous mill for cold rolling, made by the firm "Continental", serves for the rolling of cold rolled thin steel sheet up to 1500 mm wide and 0.5 or more mm thick (Fig. 4). The mill stands at a right angle to the main floor and is equipped with machinery for setting-in coiled steel sheet and an electro-mechanical apparatus placed after the finishing stand for measuring the thickness of the sheet during the rolling process. Speed of rolling - 15.5 m/sec. Working rolls are steel made, forged and hardened; life of the set until it is completely worn is 12,000 ton. Working rolls are mounted on roller bearings, backing rolls on liquid friction bearings, electric motors for the drive of all stands are of 13,000 HP. The mill output is 100 t/hr.

Four-rolls, reversible, cold rolling mill (Fig. 5) for making of thin strip in coils, up to 1500 mm wide and 0.2 or more mm thick, which then goes for the production of tin plate, as well as for making of thin carbon-steel sheet. The mill operates with overloads, its output is 60 t/hr. This mill is also provided with an apparatus for the automatic measurement of strip thickness during the process of rolling.

During the rolling of thin sheet the rolls are lubricated with palm oil, on rolling thicker steel sheet an emulsion, based on mineral oil, is used.

The machine for strip degreasing consists of equipment for strip decoiling and flattening, and baths for degreasing with caustic soda solution in an electric field. At the end of the line there are baths for washing and equipment for drying the strip with heated steam. Speed of strip is 610 m/ min.

The section for annealing thin sheet contains four-pile cupola furnaces: 2-3 coils are placed in a pile. Owing to the heating in an inert atmosphere, there is no scale on the surface of the coils after annealing. The coils are cooled with air supplied by blowers; interlayers with thread-like grooves for the passage of air are placed between the coils in a pile.

The equipment for cutting the coils into separate sheets consists of two cutting machines which are placed at an angle to the length of the main floor and join the floor of the tinning machines. On sorting the sheets the main flow goes in three streams on the upper conveyor, the defective sheets are sent on an additional conveyor situated below the main one.

Tin plating is done by a hot method on four tinning machines made by the Vin firm. A distinctive feature of these machines is that the pickling of the sheets, prior to plating, is done in a bath mounted in the plating machine. Designed output of the machine is 1.5 t/ hr, actual output - 25t/ day. The fifth tinning machine is being dismantled and in its place a tin plate sorting machine will be installed.

Tin consumption amounts to 600 gm per one standard box (according to another report it is 20 - 70 gm per sq. m of sheet surface). Two workers are employed at each tinning machine.

A continuous equipment for thin coil steel galvanizing, put into operation in August, 1956, is designed for galvanizing coil steel 1500 mm wide without the preliminary degreasing and consists of a machine for de-coiling, rollers for strip tightening, a special heat-treatment furnace, a coating pot for dipping coil steel into molten zinc, with two rollers of different diameter; a run-out section at the end of which there is a coiling machine for coiling galvanized strip. Galvanized steel is supplied in sheets and in coils.

The thermal treatment furnace, built by the American firm "Electric Combustion Co.", is about 100 m long. Mechanical equipment has been supplied by the Etna-Standard firm. Output - 10 t/ hr.

Grades of sheet steel rolled at the Cornigliano Works are given in the table.

NEW BOOKS

I. CHURSINOV: "HOW WE ROLL TUBES." Profizdat, 1956

The author, a foreman of tube rolling plant 140 of the Pervouralsk Novotrubny Works, relates the experiences of revealing hidden potentialities for an increase in production efficiency and for an improvement and cost reduction of manufactured goods.

The creative endeavours of the foreman and his team to improve methods of operation, to rationalize the use of equipment and to improve the organization of auxiliary operations, taking into account modernization and mechanization of existing machinery, have contributed to the attainment of high efficiency in the tube rolling plant. The team succeeded in achieving substantial results in output increase by adopting several new measures and initiated a socialist competition for a combined economy of metal, fuel, equipment and electric power.

The author describes the process of tube manufacture. This chapter is illustrated with appropriate figures.

The narrative of the innovator extends outside the boundaries of advanced experience information, as the author mentions such problems as the organization of active technical information, improvement of existing, and designing of new, equipment, a more clear-cut planning and organization of auxiliary operations and many other questions, the solution of which lies within the competence of the leaders of industry and administration.

In spite of the fact that the description of the advanced experience of the team refers to a specialized production – tube manufacture – the booklet will, doubtless, be useful to workers in other branches of industry.

The publication of innovators booklets not only promotes the adoption of new methods, but also helps by acquainting plant managers, party and trade union bodies with the organization of leadership of creative initiative in large personnel groups.

METALLURGIST IN ENGLISH TRANSLATION

July, 1957

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